Chapter 6 Present Situation of Port Management and Operation

6-1 Organization

6-1-1 Organization Structure and Function

There are eleven major ports in india. Development and management of these major ports is constitutionally the responsibility of the Government of India. The Indian Ports Act, 1908 provides the statutory authority for management and the Major Port Trusts Act, 1963 contains the statutory provisions for the constitution of Port Trust Boards and vesting in them the administration, control and management of the major ports.

The Chairman and Deputy Chairman are appointed by the Central Government, and the planning and development of port facilities are coordinated by the government. Approval of the government is required for major investment decisions. Plan schemes which are included in the Five Year Plan approved by the Parliament after having processed through respective Ministries and the Planning Commission are required to be sanctioned to start the work as follows;

(1) Cost up to 15 million Rs. - Board's Power
(2) Between 15 million Rs. and 50 million Rs. - MOST
(3) Over 50 million Rs. to less than 200 million Rs.- Expenditure Finance Committee through the Ministry
(4) 200 million Rs. up - Public Investment Board and the Cabinet

The Port Trusts function as autonomous, corporate, legal entities and are expected to manage and administer the ports on commercial principles under the overall administrative and financial control of the Central Government.

Fig. 6-1-1 shows the organization structure and departmental function of Calcutta Port Trust.

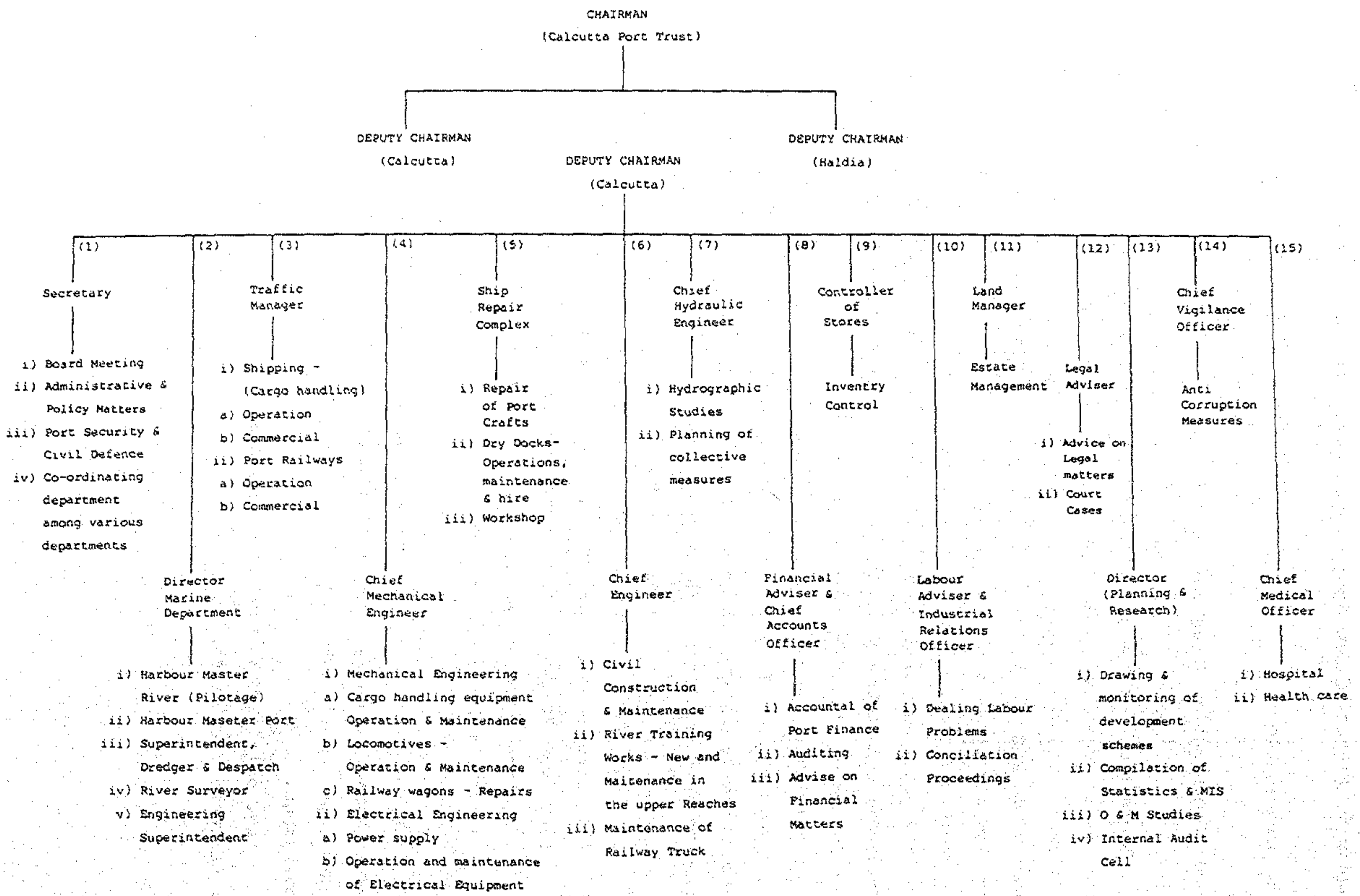


Fig. 6-1-1 Organization Structure of CPT

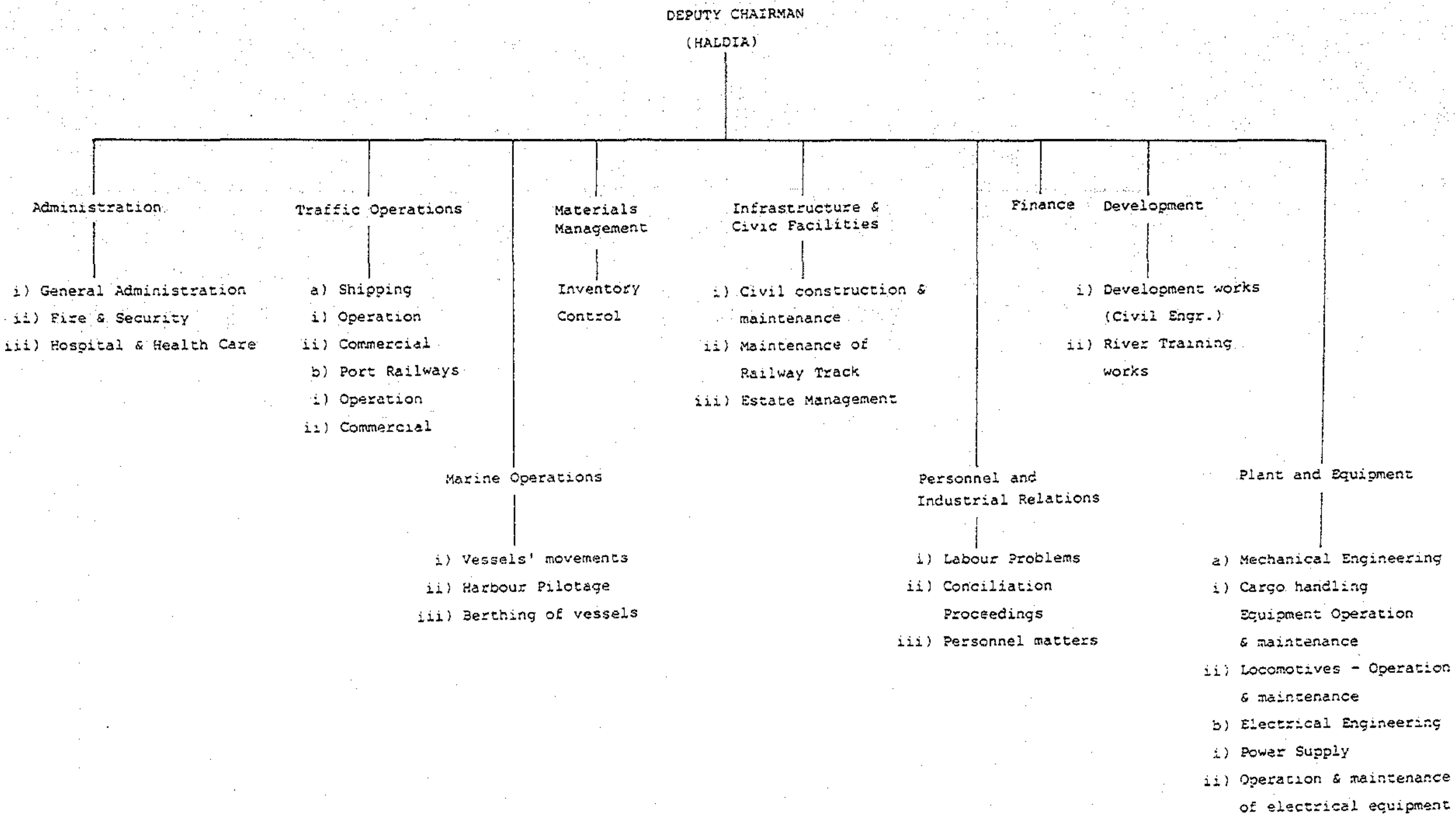


Fig. 6-1-1 Organization Structure of CPT (Continued)

6-1-2 Staff Strength

Table 6-1-1 and Table 6-1-2 below shows the staff strength of Calcutta and Haldia Dock Systems respectively.

Table 6-1-1 Staff Strength at Calcutta Dock System as on 1.1.88.

Department	Class I	Class II	Class III	Class IV	Total
SECRETARY	13	3	149	579	744
LEGAL ADV.	4	-	19	5	28
L.A. & I.R.O	12	-	34	44	90
F.A. & C.A.O	35	8	792	125	960
C.M.O	63	-	210	1,448	1,721
LAND MANAGER	4	1	63	54	122
C.O.S.	16	-	169	174	359
T.M.	72	10	2,310	3,203	5,595
C.M.E	28	14	2,280	1,570	3,892
C.E.	79	11	587	1,291	1,968
D.M.D	282	75	1,344	2,697	4,398
C.H.E.	30	6	113	100	249
S.R.C.	33	27	1,797	1,199	3,056
C.V.O	2	3	15	22	42
P & R Deptt.	7	3	17	7	34
Total	680	161	9,899	12,518	23,258

Table 6-1-2 Staff Strength at Haldia Dock System as on 31.3.88.

Department	Class I	Class II	Class III	Class IV	Total
Administration	22	1	97	213	333
P & I.R	9	-	49	9	67
T.O.	12	14	279	449	754
Finance	10	1	86	12	109
P & E	18	63	679	661	1,421
I & CF	21	7	181	332	541
M.O	21	2	69	76	168
M.M.	5	1	13	6	25
Dev. Cell	13	5	54	11	83
Total	131	94	1,507	1,769	3,501

6-2 Cargo Handling Operation

In this section, the present situation of the cargo handling operations at Calcutta and Haldia are analysed by cargo type from the view point of (a) ship performance, (b) comparison among major ports and (c) productivity of shore-side work, and present critical problems are identified in order to realise the maximum utilisation of existing port resources.

The main indicators used for the analysis of ship performance by ship type are as follows:

A. Average output per effective working hour

This indicates the cargo handling efficiency at ship face per net working hour per ship and the non-working time at berth that reduces the ship day output is excluded. On the other hand, such factors as the gang strength per ship, utilization of cargo handling equipment and working time of the port in question are neglected.

B. Average non-working time at berth

This indicator shows the strength of impediments to cargo handling operation at ship face provided that some portion of the non-working time is necessary from the viewpoint of ship maneuvering. This indicator is not influenced by ship size or parcel size.

C. Average pre-berthing waiting time

This indicates the strength of impediments such as the non-availability of suitable berths in the port.

The correlation between each indicator is shown in Fig. 6-2-1 below.

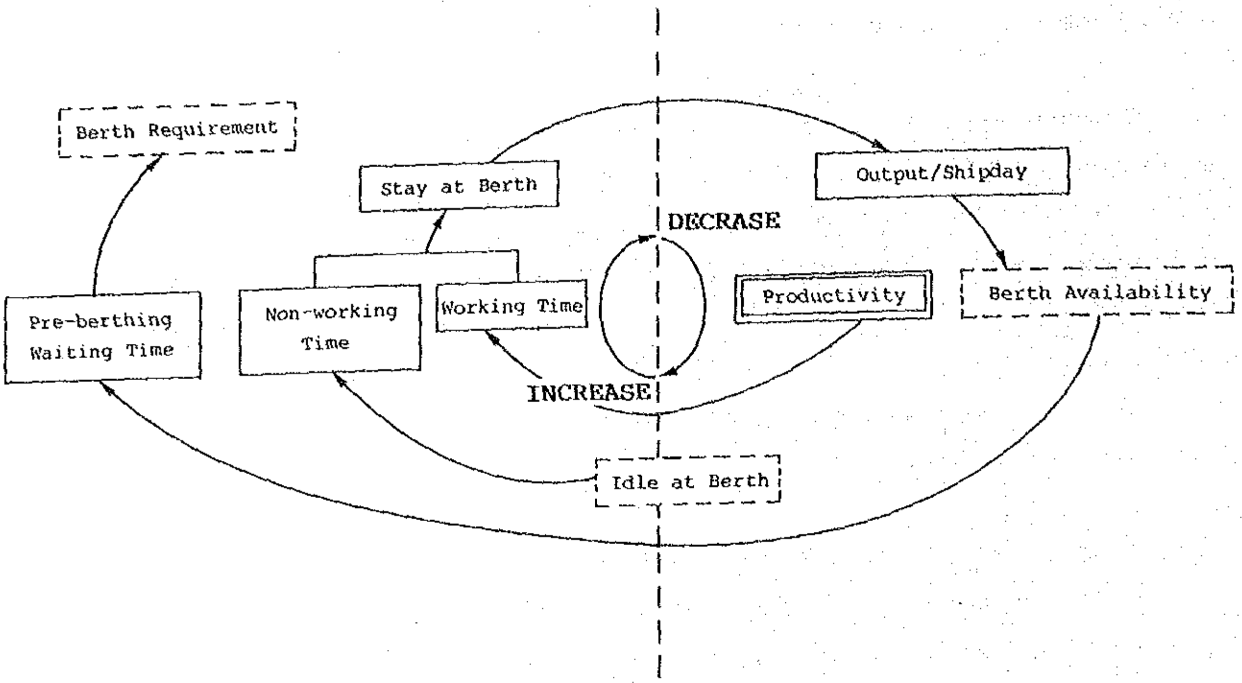


Fig. 6-2-1 Correlation of Each Indicator (Negative Case)

6-2-1 Containers

(1) Calcutta

The volume of containerised cargo handled at Calcutta in 1987/88 was as follows:

On the import side, a total of 2.18 lakh tonnes of which 0.22 lakh tonnes (10.1%) were "Chemicals". On the export side, out of a total of 2.69 lakh tonnes, 0.64 lakh tonnes (23.8%) were "Jute and jute products", 0.55 lakh tonnes (20.4%) were "Cast iron goods", 0.3 lakh tonnes were "Tea" and 0.23 lakh tonnes (8.6%) were "Mica". These four items comprised 63.9% of the total containerised cargo exported.

1) Ship performance

Table 6-2-1 below shows the performance of container ships in the last five years.

Table 6-2-1 Performance of Container Ships (Calcutta)

(in days)

Sl. No.	Description	83/84	84/85	85/86	86/87	87/88
1.	No. of ships	46	92	138	173	162
2.	Total cargo handled ('000 Tonnes)	195	248	397	475	502
3.	Total No. of containers (TEUs)	18,165	22,064	39,874	45,015	43,800
4.	Avg. parcel size (TEUs)	395	240	289	260	270
5.	Avg. output per ship day (TEUs)	125	55	74	78	93
6.	Avg. pre-berthing time	-	0.10	0.20	0.20	0.15
7.	Avg. stay at berth	3.15	4.36	3.92	3.32	2.90
8.	Avg. working time	2.08	3.08	2.91	2.35	2.11
9.	Avg. non-working time	1.06	1.28	1.01	0.97	0.79
10.	Working/stay time ratio	0.66	0.71	0.74	0.71	0.73
11.	Avg. TEUs handled per effective hour (*)	8	3	4	5	5

(*) Avg. No.of containers handled per ship/Avg. working time in hours

Source; CPT

The main features are as follows:

(a) Average output per ship day has been increasing gradually in recent years due to the improvement of ship face produtivity and average working time has decreased accordingly.

(b) Average non-working time has been decreasing.

(c) Average pre-berthing time is stable.

2) Comparison among Major Ports

Table 6-2-2 below shows the performance of container ships at major ports in 1986/87.

Table 6-2-2 Performance of Container Ships
(1986/87 : in days)

Sl. No.	Description	Calcutta	Haldia	Bombay	Madras	Cochin	Visag	Mormugao	Paradip	Kandla	Tuticorin	New Mangalore	All Ports
1.	No. of Ships	173	85	586	295	217	26	-	-		55		1,437
2.	Total Cargo Handled ('000 tonnes)	475	127	2,618	890	225	12	-	-		76		4,423
3.	Avg. percel size (tonnes)	2,745	2,540	4,468	3,018	1,037	465	-	-		1,373		3,078
4.	Avg. Output Ship Day (tonnes)	926	940	1,617	2,053	564	198	-	-		1,414		1,332
5.	Avg. Pre-berthing Time	0.20	0.43	0.20	0.31	0.37	0.48	-	-		0.08		0.26
6.	Avg. Stay at Berth	3.32	2.17	2.76	1.47	1.84	2.34	-	-	NA	0.97	NA	2.31
7.	Avg. Working Time	2.35	0.95	2.05	0.76	0.96	1.53	-	-		0.55		1.52
8.	Avg. Non-working Time	0.97	1.22	0.71	0.71	0.88	0.81	-	-		0.42		0.79
9.	Working/Stay Time Ratio	0.71	0.44	0.74	0.52	0.52	0.65	-	-		0.57		0.66
10.	Avg. Output per Effective Working Hour (tonnes)	49	66	91	165	45	13	-	-		105		84

Source: Annual reports in 1986/87 of each port

The main features are as follows:

(a) Average output per ship day at Calcutta was better than at Cochin but only 58% of that at Tuticorin which recorded remarkable productivity without shore side gantry crane. Regarding container handling facilities, it was observed during the site survey at Tuticorin that there is a 130 m width container parking yard just behind the berth and the CPY may contribute to the high efficiency.

(b) Average pre-berthing time at Calcutta was lower than the average of the seven major ports

(c) On the other hard, average non-working time at Calcutta was the longest next to Haldia.

3) Productivity of Shore side Work

The poductivity of container handling in 1985/86 and 1986/87 was 19 TEUs and 21 TEUs per hook per shift respectively. It is said that the handling productivity of containers is, in general, 10-15 boxes per hour per ship gear or mobile crane. This is equal to one box every 4-6 minutes (e.g. Manila Port: 7-16 boxes, Bangkok Port: 9-14 boxes). Assuming the low case of 10 boxes per hour per crane as rated capacity and 15% - 30% of time loss per shift due to operational necessity such as shifting holds and opening/closing of hatches etc., effective productivity is calculated as follows:

Effective productivity = 10 boxes x 7.3 hours x 0.7 - 0.85
= 51 boxes - 62 boxes / hook shift

N.B. Rated and effective productivity are defined as follows by UNCTAD.

Rated productivity : Defined as the number of tonnes per gang, crane, shiploader, etc. handled when it works for one hour without interruptions.

Effective productivity: defined as the number of tonnes handled when it works for one hour with the interruptions which tend to happen during any shift and the consequent idle time that reduces the shift output.

The number of 40' containers handled in 1986/87 was 7,928 boxes and the number of TEUs in the same year was 49,793. This suggests a productivity of 18 boxes per hook per shift instead of 21 TEUs and the percentage of the actual productivity to the above index is 29-35%.

The reasons for the low productivity of container handling at Calcutta are assumed as follows:

(a) lack of necessary communication exchange among the related parties such as the shipping company, steamer agent, stevedore and CPT.
(b) lack of skilled labourers for container handling
(c) lack of handling equipment such as tractors/trailers, spreaders.
(e) insufficient layout of the terminal: narrow apron, location of the existing quay side crane, congested access to the open storage yard.

(2) Haldia

The volume of containerised cargo handled at Haldia in 1987/88 was as follows:

On the import side, out of a total of 0.67 lakh tonnes handled, 0.12 lakh tonnes (17.6%) were "Waste paper", about 7,600 tonnes (11.3%) were "Machinery" and about 2,000 tonnes(3%) were "Chemicals". These three items compnised 31.9% of the total containerised cargo imported. Containerised cargo decreased due to winding down of the Korba and Rihand Projects.

On the export side, out of a total of 1.11 lakh tonnes handled, 0.66 lakh tonnes (59.7%) were "Tea", about 5,800 tonnes (5.2%) were "Batteries" and about 5,700 tonnes (5.1%) were "Jute and jute products". These three items comprised 70.1% of the total containerised cargo exported. Tea exports in 1987/88 remarkably increased as compared to 0.28 lakh tonnes in the previous year due to the full functioning of intermodal transportation from I.C.D., Guahati.

1) Ship Performance

Table 6-2-3 Performance of Container Ships (Haldia)
(in days)

Sl. No. Description	83/84	84/85	85/86	86/87	87/88
1. No. of ships	43	55	50	85	77
2. Total cargo handled ('000 Tonnes)	63	92	82	156	178
3. Total No. of containers (TEUs)	7,193	9,686	8,090	15,393	18,842
4. Avg. parcel size (TEUs)	167	176	161	181	245
5. Avg. output per ship day (TEUs)	94	89	57	83	165
6. Avg. pre-berthing time	0.14	0.25	0.40	0.43	0.21
7. Avg. stay at berth	1.78	1.98	2.86	2.17	1.48
8. Avg. working time	1.20	1.18	1.35	0.95	0.75
9. Avg. non-working time	0.58	0.79	1.51	1.22	0.73
10. Working/stay time ratio	0.67	0.60	0.47	0.44	0.51
11. Avg. TEUs handled per effective hour	6	6	5	8	13

The salient features are as follows:

(a) Average pre-berthing waiting time has gradually increased in recent years. The number of cellular and combi vessels served at Haldia in 1986/87 was 64 and 21 respectively, and 264 hours were lost due to non- availability of berths for cellular vessels. However, this was remarkably improved in 1987/88.

(b) The main reasons for non-working time at Haldia in 1986/87 were "Want of containers" = 24.5%, "Agents option" = 15.6%, "Operation necessity" = 14.8% and so on. In some cases, these delays seem to occur due to a lack of necessary communication between shipping companies and their agents. For instance, it was observed during the site survey of the berth that the chief officer was calculating the stabilization of the ship when the containers were loaded on board. This work should have been executed in advance as a stowage plan by the shipping company or its agent before the commencement of stevedoring. it, was also pointed out by CPT (Haldia) that the rule against night navigation has seriously influenced the availability of the dock system.

(c) On the other hand, cargo handling productivity had increased as shown above and average working time has decreased accordingly.

2) Comparison among Major Ports

The performance of container ships among major ports in 1986-87 is shown in table 6-2-2.

The main features are as follows:

(a) Average output per effective hour as well as average output per ship day was much lower at Haldia than at Madras and Bombay where shoreside gantry cranes are available.

(b) Average non-working time at Haldia was the highest among the seven major ports.

(c) Average pre-berthing time was also the longest next to Visag.

3) Productivity of shoreside work

Table 6-2-4 below shows the productivity of shoreside work at Haldia in the last five years.

Table 6-2-4 Productivity per Hook Shift

(in TEUs)

Handling Method	83/84	84/85	85/86	86/87	87/88
Portainer	25	26	29	48	38
Ship gear				31	25

According to CPT(Haldia), the design capacity of the portainer cycle time was 3 minutes but at present the effective capacity is 4 minutes due to ageing of the equipment. Based on this condition, hourly rated productivity is calculated as 15 TEUs. Assuming that 15% to 30% of the working hours are lost due to operational necessity such as shifting holds, opening/closing of hatches etc., the effective productivity per hook shift is calculated as follows;

Effective productvity = 15 TEUs x 7.5hours x 0.7 - 0.85
= 78 TEUs - 95 TEUs / hook shift

Thus, the percentage of the actual productivity of portainer in 1987/88 to the above index is in the range of 40% to 49%.

However, it should be pointed out that existing ship gear impede the efficient operation of portainer and interference between portainer and ship gear when they are operated simultaneously also reduces the productivity.

The reasons for the low productivity of container handling are assumed as follows:

(a) lack of necessary information exchange: communication system between Haldia and Calcutta is very poor.
(b) lack of tractors/trailers: It is essential for the terminal operation based on the transfer cranes system to match the cycle time of the movement of containers between the Container Park Yard and the hook point with the cycle time of the gantry crane.
(c) inefficient layout of the terminal: narrow apron, location of the

existing transfer crane and transit shed. The design of the transfer crane yard is not suitable for the tractor/trailer operation but rather for the rake operation.

(d) a single portainer: Shipping companies are hesitating to deploy the gearless vessels which are suitable for portainer handling.

6-2-2 Break Bulk

(1) Calcutta

The volume of break bulk general cargo handled at Calcutta in 1987/88 was as follows:

On the import side, out of the total 18.97 lakh tonnes handled, 2.24 lakh tonnes (11.8%) were "Iron and steal", 1.83 lakh tonnes (9.6%0 were "Cement", 1.46 lakh tonnes (7.7%) were "Machinery" and 0.68 lakh tonnes (3.6%) were "Sugar". These four items comprised 32.7% of total break break cargo imported.

On the export side, out of 5.26 lakh tonnes handled at Calcutta, 2.12 lakh tonnes (40.3%) were "Jute and jute products", 0.73 lakh tonnes (13.9%) were "Tea", 0.54 lakh tonnes (10.3%) were "Iron and steal". These three items comprised 64.5% of the total break bulk cargo exported.

1) Ship Performance

Table 6-2-5 below shows the performance of break bulk ships at Calcutta in the last five years.

Table 6-2-5 Performance of Break Bulk Ships (Calcullta)

(in days)

Sl. No. Description	83/84	84/85	85/86	86/87	87/88
1. No. of ships	490	431	483	509	545
2. Total cargo handled ('000 Tonnes)	1,628	1,893	1,933	1,856	2,183
3. Aveg. parcel size (Tonnes)	3,322	4,392	4,002	3,646	4,006
4. Avg. output per ship day (Tonnes)	333	358	303	335	399
5. Avg. pre-berthing time	0.57	0.65	2.38	0.73	0.76
6. Avg. stay at berth	9.99	12.27	13.19	10.88	10.05
7. Avg. working time	6.04	7.16	8.68	6.24	6.02
8. Avg. non-working time	3.96	5.11	4.51	4.64	4.03
9. Working/stay time ratio	0.60	0.58	0.66	0.57	0.60
10. Avg. output per effective hour (tonnes)	23	26	19	24	28

Source: CRT

The salient features are as follows:

(a) average parcel size has been stable.

(b) average output per ship day and average output per effective hour have improve during the last three years, and

(c) average pre-berthing time has increased in recent years

According to the annual report, average pre-berthing time in 1985/86 increased sharply due to the intensification of an anti-corruption drive.

2) Comparison among Major Ports

Table 6-2-6 below shows the per hook per shift productivity of break major ports in India in 1986/87.

Table 6-2-6 Performance of Break Bulk Ships
(1986/87 : in days)

Sl. No.	Description	Calcutta	Haldia	Bombay	Madras	Cochin	Visag	Mormugao	Paradip	Kandla	Tuticorin	New Mangalore	All Ports
1.	No. of Ships	509	27	627	439	189	154	35	40		92		2,312
2.	Total Cargo Handled ('000 tonnes)	1,856	104	3,487	1,308	282	582	144	115		261		8,139
3.	Avg. parcel size (tonnes)	3,645	3,837	4,470	2,986	1,493	3,778	3,998	2,868		2,838		3,520
4.	Avg. Output Ship Day (tonnes)	335	479	598	663	351	711	359	427		587		492
5.	Avg. Pre-berthing Time	0.73	2.85	0.27	0.47	0.83	0.67	2.28	1.45		0.17		0.56
6.	Avg. Stay at Berth	10.88	8.01	7.47	4.50	4.27	5.31	8.71	6.72	NA	4.84	NA	7.16
7.	Avg. Working Time	6.24	4.14	4.57	2.22	1.84	3.14	5.64	4.76		2.84		4.12
8.	Avg. Non-working Time	4.64	3.87	2.90	2.28	2.43	2.17	3.07	1.96		2.00		3.04
9.	Working/Stay Time Ratio	0.57	0.52	0.61	0.49	0.43	0.59	0.65	0.71		0.59		0.58
10.	Avg. Output per Effective Working Hour (tonnes)	24	39	38	56	34	50	30	25		42		36

Source: Annual reports in 1986/87 of each port

The salient features are as follows:

(a) average output per ship day and average output per effective working hour at Calcutta were the lowest among nine major ports in spite of recent improvements of these indicators.

(b) Average pre-berthing waiting time, was 1.3 times the major ports average. This was largely due to non-availability of suitable berts, which accounted for 26% of pre-berthing detention in 1986/87.

(c) average non-working time was also the longest among the major ports, i.e. 4.64 days per ship. Main reason was "ship's option prior to sail" which comprised 43% of the time lost at berth in 1986/87.

3) Productivity of shoreside Work

Table 6-2-7 below shows the per hook per shift productivity of break bulk cargo at Calcutta in the last three years.

Table 6-2-7 Productivity per Hook Shift
(in Tonnes)

Sl.No. Commodity	85/86	86/87	87/88	Avg.
1. Sugar	93.53	135.62	129.07	119.41
2. Cement	124.42	144.34	143.17	137.31
3. Other general cargo	69.29	83.12	89.86	80.76

The following table shows the productivity of Madras and Visakhapatnam.

Table 6-2-8 Productivity of Other Ports
(in tonnes/hook shift)

Sl. No. Commodity	85/86		86/87		87/88		Avg.	
	Madras	Visag	Madras	Visag	Madras	Visag	Madras	Visag
1. Sugar	148	170	154	222	139	174	147	189
2. Cement	164	130	152	154	155	-	157	142
3. Other general cargo	114	113	120	137	119	107	118	119

Source:Annusl Reports of each Port

Regarding average productivity of other general cargo, the level at Calcutta was of 68% of the leves at Madras and Viskhapatnam. The weighted average of 95 tonnes per hook per sift in 1987/88 is also lower than in some countries in the Southeast Asia.

Table 6-2-9 Productivity of Other Countries

(in Tonnes per gang hour)

	Bangkok	Manila	Singapore	Jakarta
General Cargo	15.3	15.0	21.0	20.75

Source: JICA Study Reports

Taking into consideration that Calcutta plays a significant role in the handling of break bulk general cargo, the low productivity at the port should be improved so as to meet the forecast future demand.

The following are assumed to be the reasons for the low productivity of the break bulk cargo handling.

(a) lack of necessary communication exchange among the port related parties: Conventional cargo handling involves more variables than container handling such as the capacity of ship gear, location of the cargo on board, packing type/parcel size of the cargo, strength of the gang and necessary number of gangs and equipment.

(b) lack of skilled labourers,

(c) lack of necessary equipment such as forklifts and their attachments used for the handling of various types of cargo, pallets, trucks and so on,

(d) insufficient packing of cargo,

(e) deterioration of ship gear and equipment and

(f) inefficient layout of berth.

(2) Haldia

The volume of break bulk general cargo handled at Haldia in 1987/88 was as follows:

On the import side, out of the total of 1.08 lakh tonnes handled, 39,980 tonnes (37.1%) were "Steel billets", 10,654 Tones (9.9%) were "Zinc and Pig lead", 10,276 Tonnes (9.5%) were "Edible oil", 8,495 tonnes (7.9%) were "Cement" and 7,529 tonnes were "Soda ash". These five items comprised 71.4% of the total break bulk cargo imported. Sugar and cement volume decreased in 1987/88 due to the Government policy of distributing these cargo among the major ports. On the other hand, there was no break bulk cargo exported in 1987/88.

1) Ship performance

Table 6-2-10 below shows the performance of break bulk ships at Haldia in the last five years.

Table 6-2-10 Performance of Break Bulk Ships (Haldia)
(in days)

Sl. No. Description	83/84	84/85	85/86	86/87	87/88
1. No. of ships	46	37	40	27	24
2. Total cargo handled ('000 Tonnes)	113	127	149	104	108
3. Aveg. parcel size (Tonnes)	2,457	3,432	3,725	3,837	4,500
4. Avg. output per ship day (Tonnes)	452	600	705	479	573
5. Avg. pre-berthing time	2.28	6.22	4.90	2.85	4.28
6. Avg. stay at berth	5.43	5.72	5.28	8.01	7.82
7. Avg. working time	2.80	3.72	2.67	4.14	4.92
8. Avg. non-working time	2.62	2.00	2.61	3.87	2.90
9. Working/stay time ratio	0.52	0.65	0.51	0.52	0.63
10. Avg. output per effective hour (tonnes)	37	38	58	39	38

The main features are as follows:

(a) Average parcel size has been increasing gradually.

(b) Average output per effective hour has decreased from 58 tonnes in 1985/86 to 38 tonnes in 1987/88. This may be largely due to the change in the cargo mix i.e. from bagged cargo such as cement and sugar to steel billets and zinc/pig lead in the last three years. This trend as well as the increase of average percale size pushed up average working time to the level of 4.92 days, accordingly.

(c) Average pre-berthing waiting time was too long mainly due to non-availability of suitable berths.

2) Comparison among Major Ports

The performance of break bulk ships among the major ports is shown Table 6-2-6.

(a) Average pre-berthing waiting time at Haldia in 1986/87, even though it was the lowest in the last four years, was still the longest among the major ports. This was mainly due to the non-availability of suitable berths.

(b) Average non-working time at berth in 1986/87 was the longest next to Calcutta Mainly due to "Ship's account", i.e. 72% of the total time lost at berth.

3) Productivity of Shore side Work

Table 6-2-11 below shows the productivity of break bulk cargo at Haldia in the last three years.

Table 6-2-11 Productivity per Hook Shift
(in Tonnes)

Sl. No. Commodity	85/86	86/87	87/88
1. Cement(Bagged)	104.61	95.98	118.60
2. Sugar	145.42	110.09	-
3. Soda ash	124.20	65.40	63.26
4. General import	144.43	139.28	102.35
5. Salt	-	70.06	-
6. Steel(Coils, Billets Pipes, Rail)	Included in col.4	-do-	85.80
7. Drums			65.77
8. Foodgrain			110.33
9. Pig iron			103.00
10. Zinc, Pig lead			156.67
11. Machinery			60.17

The weighted average of 121 tonnes per hook per shift in 1986/87 is within the same level as at Bangkok and Manila.

6-2-3 Dry Bulk

(1) Calcutta

The volume of dry bulk cargo handled at Calcutta in 1987/88 was as follows:

On the import side, out of the total of 4.14 lakh tonnes, 1.84 lakh tonnes (44.4%) were "Raw materials for fertilizer", 1.53 lakh tonnes

(37.0%) were "Fertilizer" and 0.62 lakh tonnes (15.0%) were "Foodgrains". These three items comprised 96.4% of the total dry bulk cargo imported. On the other hard, only 8 thousand tonnes of coal was exported in 1987/88.

1) Ship Performance

Table 6-2-12 below shows the performance of dry bulk ships at Calcutta in the last five years.

Table 6-2-12 Performance of Dry Bulk Ships (Calcutta)

(in days)

Sl. No.	Description	83/84	84/85	85/86	86/87	87/88
1.	No. of ships	189	96	81	66	69
2.	Total cargo handled ('000 Tonnes)	1,476	843	702	391	429
3.	Aveg. parcel size (Tonnes)	7,810	8,781	8,667	5,924	6,217
4.	Avg. output per ship day (Tonnes)	528	484	499	466	501
5.	Avg. pre-berthing time	3.41	2.57	4.78	0.97	1.33
6.	Avg. stay at berth	14.80	18.15	17.36	12.71	12.40
7.	Avg. working time	7.49	10.03	12.05	7.67	6.71
8.	Avg. non-working time	7.30	8.12	5.31	5.04	5.68
9.	Working/stay time ratio	0.51	0.55	0.69	0.60	0.54
10.	Avg. output per effective hour (tonnes)	43	36	30	32	39

The number of ships and the total cargo handled at Calcutta has decreased mainly due to the decrease of coal handling. The average pre-berthing time in 1986/87 decreased remarkably to 0.97 days per ship as compared to 4.78 days per ship in the previous year due to the decrease of time lost in non-availability of suitable berths.

Regarding the reasons for non-working time in Calcutta, "Ships option" = 12.9%, "Time taken in opening hatch" = 12.2% and "Lack of cargo" = 6.8% were the main reasons cited.

2) Comparison among Major Ports

Table 6-2-13 Performance of Dry Bulk Ships (Conventional)
(1986/87 : in days)

Sl. No.	Description	Calcutta	Haldia	Bombay	Madras	Cochin	Visag	Mormugao	Paradip	Kandla	Tuticorin	New Mangalore	All Ports
1.	No. of Ships	66	34	137	111	34	298	47	101		40		868
2.	Total Cargo Handled ('000 tonnes)	391	462	1,904	1,931	604	2,760	1,156	2,159		459		11,826
3.	Avg. percel size (tonnes)	5,924	15,940	14,533	17,393	17,768	18,906	25,594	21,376		11,481		13,624
4.	Avg. Output Ship Day (tonnes)	466	2,271	1,145	1,301	673	1,784	1.358	2,500		1,590		1,150
5.	Avg. Pre-berthing Time	0.97	2.76	2.30	1.31	3.47	1.69	0.54	2.01		0.20		1.70
6.	Avg. Stay at Berth	12.71	7.01	12.68	13.37	28.03	10.59	15.45	8.56		7.22		11.85
7.	Avg. Working Time	7.67	5.03	9.21	8.11	14.45	6.92	10.99	6.92		5.93		7.87
8.	Avg. Non-working Time	5.04	1.98	3.47	5.26	13.58	3.67	4.46	1.74		1.30		3.98
9.	Working/Stay Time Ratio	0.60	0.72	0.73	0.61	0.52	0.65	0.71	0.80		0.82		0.66
10.	Avg. Output per Effective Working Hour (tonnes)	32	113	63	89	51	56	93	131		81		72

Source: Annual reports in 1986/87 of each port

Due to the transfer of dry bulk handling facilities to Haldia, average parcel size was less than half of the nine ports' average. Taking this into consideration, the average stay at berth should be improved through reduction of non-working time and establishment of efficient cargo handling productivity. The productivity at Calcutta was the worst among the major ports.

(2) Haldia

Dry bulk cargo which was handled by both mechanical and conventional operation in 1987/88 was as follows:

On the import side, out of the total of 6.46 lakh tonnes, 5 lakh tonnes (77.5%) were "Coking coal", 0.78 lakh tonnes (12.1%)were "Rock phosphate", 0.36 lakh tonnes (5.6%) were "Sulphur" and 0.3 lakh tonnes (4.7%)were "Finished fertilizer". These four items comprised 99.8% of the total dry bulk cargo imported. On the export side, a total of 26.2 lakh tonnes of coal was exported.

1) Ship Performance

Table 6-2-14 below shows the performance of dry bulk ships at Haldia in the last five years.

Table 6-2-14 Performance of Dry Bulk Ships (Haldia)
(in days)

Sl. No.	Description	83/84	84/85	85/86	86/87	87/88
1.	No. of ships	116	114	139	131	146
2.	Total cargo handled ('000 Tonnes)	1,931	1,872	3,066	2,656	3,270
3.	Aveg. parcel size (Tonnes)	16,647	16,421	22,058	20,275	22,397
4.	Avg. output per ship day (Tonnes)	2,788	2,032	3,047	4,007	5,410
5.	Avg. pre-berthing time	6.5	8.46	3.94	1.82	2.76
6.	Avg. stay at berth	5.97	8.08	7.24	5.06	4.22
7.	Avg. working time	3.02	3.73	3.11	2.26	2.14
8.	Avg. non-working time	2.96	4.35	4.14	2.80	2.08
9.	Working/stay time ratio	0.51	0.46	0.43	0.45	0.51
10.	Avg. output per effective hour (tonnes)	230	183	296	374	436

Average working time and average output per effective working hour have improved remarkably in recent years. The reasons for idle time of dry bulk ships at Haldia were "Operation necessity" = 34.6%, "Agents' option" = 24.6% "Breakdown/shutdown" = 17.1% and so on.

Fig. A-6-1-3 shows the long pre-berthing time from Sandheads to the coal berth on January 1988 due to the non-availability of the berth.

The following Table 6-2-15 shows the ship face performance of mechanized and conventional operations separately in order to analyse the performance indicators in more detail.

Table 6-2-15 Operation wise Performance (Dry Bulk)

Sl. No.	Description	86 / 87		87 /88	
		M	C	M	C
1.	No. of ships	102	34	117	29
2.	Total cargo handled ('000 Tonnes)	2,194	462	2,732	538
3.	Avg. parcel size (Tonnes)	21,508	15,931	23,350	18,552
4.	Avg. output per ship day (Tonnes)	4,777	2,271	6,578	2,845
5.	Avg. pre-berthing time	1.33	2.76	3.02	1.69
6.	Avg. stay at berth	4.50	7.01	3.55	6.52
7.	Avg. working time	1.47	5.03	1.44	4.70
8.	Avg. non-working time	3.03	1.98	2.11	1.82
9.	Working / stay time ratio	0.33	0.72	0.41	0.72
10.	Avg. output per effective hour (Tonnes)	610	113	676	164

M: Mechanized Operation C: Conventional Operation

N.B. Out of 34 ships operated conventionally in 86/87, 5 ships were double-counted due to duplicated operations both mechanical and conventional.

Regarding mechanically operated ships, the average output per ship day in 1987/88 increased to of 1.38 times over to the previous year. On the other hand, the average pre-berthing waiting time dropped to 3.02 days as compared to 1.33 days in 1986/87, and the average non-working time remained at the level of 59.4% of the total time spent at berth. Regarding corventionally operated ships, all indicators mentioned in the Table improved remarkably, mainly due to productivity increases.

2) Comparison among Major Ports

Regarding conventional dry bulk ships, all the indicators except pre-berthing waiting time, which decreased in 1987/88 exceeded the nine port average (See Table 6-2-14).

Table 6-2-16 below shows the performance of dry bulk ships operated mechanically among major ports in 1986/87.

Table 6-2-16 Performance of Dry Bulk Ships (Mechanized)
(1986/87 : in days)

Sl. No.	Description	Calcutta	Haldia	Bombay	Madras	Cochin	Visag	Mormugao	Paradip	Kandla	Tuticorin	New Mangalore	All Ports
1.	No. of Ships	-	102	-	73	-	70	196	57		115		613
2.	Total Cargo Handled ('000 tonnes)	-	2,194	-	5,304	-	6,146	13,088	2,079		2,603		31,414
3.	Avg. parcel size (tonnes)	-	21,508	-	72,655	-	87,797	66,777	36,478		22,639		51,246
4.	Avg. Output Ship Day (tonnes)	-	4,777	-	34,432	-	16,599	7,938	11,210		8,682		13,666
5.	Avg. Pre-berthing Time	-	1.33	-	0.98	-	1.81	3.75	4.82	NA	1.71	NA	2.51
6.	Avg. Stay at Berth	-	4.50	-	2.11	-	5.29	4.25	3.25		2.61		3.75
7.	Avg. Working Time	-	1.47	-	0.87	-	2.16	3.39	1.05		2.18		2.19
8.	Avg. Non-working Time	-	3.03	-	1.24	-	3.13	0.86	2.20		0.43		1.57
9.	Working/Stay Time Ratio	-	0.33	-	0.41	-	0.41	0.80	0.32		0.84		0.58
10.	Avg. Output per Effective Working Hour (tonnes)	-	610	-	3,480	-	1,694	821	1,447		433		975

Source: Annual reports in 1986/87 of each port

Haldia and Tuticorin are closely linked together through thermal coal transportation. The former functions as a loading port for coal and the latter as a discharging port, and the average parcel size per ship of these two ports is 21,508 tonnes and 22,639 tonnes respectively. The average output per effective working hour was 610 tonnes at haldia and 433 tonnes at Tuticorin where discharge of coal is executed using ship gear and a one lane belt coveyor system. However, the average output per ship day was 4,777 tonnes at Haldia compared to 8,682 tonnes at Tuticorin due to the longer average non-working time at Haldia.

During the site survey at Tuticorin, it was observed that many workers were deployed along side the coveyor in order to remove stones mingled with coal. This was also a serious problem at the opposite side of the sea-borne trade. Therefore, quality control of thermal coal should be earnestly taken into consideration from the view point of cost reduction because these stones are transported far away from the mine to Tuticorin by both rail and sea and impede the efficient utilisation of port facilities at both sides.

6-2-4 Liquid Bulk

(1) Calcutta

The volume of liquid bulk handled at Calcutta in 1987/88 was as follows:

On the import side, but of the total 9.86 lakh tonnes handled, 8.31 lakh tonnes (84.3%) were "POL products" and 1.24 lakh tonnes (12.6%) were "Edible oil". These two items comprised 96.9% of the total liquid bulk imported. On the export side 0.75 ;lakh tonnes of "POL products" were exported.

Table 6-2-17 below shows the performance of liquid bulk ships at Calcutta in the last five years together with Table 6-2-18 which indicates the comparison of major ports in 1986/87.

Table 6-2-17 Performance of Liquid Bulk Ships (Calcutta)
(in days)

Sl. No. Description	83/84	84/85	85/86	86/87	87/88
1. No. of ships	79	121	130	150	157
2. Total cargo handled ('000 Tonnes)	599	796	872	691	813
3. Aveg. parcel size (Tonnes)	7,582	6,579	6,708	4,605	5,178
4. Avg. output per ship day (Tonnes)	2,284	1,812	2,630	1,925	2,183
5. Avg. pre-berthing time	0.44	0.35	0.02	0.56	0.48
6. Avg. stay at berth	3.32	3.63	2.55	2.39	2.37
7. Avg. working time	1.87	1.66	1.37	1.23	1.27
8. Avg. non-working time	1.45	1.97	1.18	1.11	1.10
9. Working/stay time ratio	0.56	0.46	0.54	0.54	0.54
10. Avg. output per effective hour (tonnes)	169	165	204	150	170

The number of ships has increased gradually in recent years and average non-working time has been reduced. However, average output per ship day fluctuated year by year.

Tabel 6-2-18 Performance of Liquid Bulk Ships (1986/87 : in days)

Sl. No.	Description	Calcutta	Haldia	Bombay	Madras	Cochin	Visag	Mormugao	Paradip	Kandla	Tuticorin	New Mangalore	All Ports
1.	No. of Ships	150	322	617	329	254	276	154	38		105		2,245
2.	Total Cargo Handled ('000 tonnes)	691	4,938	17,417	10,343	5,771	5,415	1,022	494		712		5,200
3.	Avg. parcel size (tonnes)	4,605	15,334	28,413	31,436	22,719	19,621	6,639	12,995		6,782		46,803
4.	Avg. Output Ship Day (tonnes)	1,925	12,294	12,060	17,964	14,427	11,904	4,846	9,845		5,340		11,684
5.	Avg. Pre-berthing Time	0.56	1.10	0.82	1.47	0.69	1.03	1.28	0.44	NA	0.29	NA	0.95
6.	Avg. Stay at Berth	2.39	1.25	2.36	1.75	1.53	1.64	1.37	1.32		1.27		1.79
7.	Avg. Working Time	1.28	0.70	1.49	1.23	1.03	1.09	0.87	1.32		0.79		1.15
8.	Avg. Non-working Time	1.11	0.55	0.87	0.50	0.50	0.55	0.50	N.A.		0.48		0.67
9.	Working/Stay Time Ratio	0.54	0.56	0.63	0.70	0.67	0.66	0.64	1		0.62		0.64
10.	Avg. Output per Effective Working Hour (tonnes)	150	913	789	1,065	919	750	318	410		358		754

Source: Annual reports in 1986/87 of each port

Comparing the performance at Calcutta with that at Mormugao and Tuticorin, which handled ships roughly the same parcel size, performance at Calcutta in terms of average output per effective hour and average non-working time was the lowest among the three ports.

(2) Haldia

The volume of liquid bulk cargo handled at Haldia in 1987/88 was as follows:

On the import side, out of a total of 45 lakh tonnes, 27.2 lakh tonnes (60.4%) were "POL crude", 16.7 lakh tonnes (37.0%) were "POL products", 0.9 lakh tonnes (2.1%) were "Phosphoric acid" and 0.2 lakh tonnes (0.5%) were "Liquid anmonia.

On the export side, a total of 4.4 lakh tonnes of "POL products" were exported in 1987/88.

Table 6-2-19 below shows the performance of liquid bulk ships at Haldia in the last five years and that at major ports in 1986/87 is mentioned in Table 6-2-18 above.

Table 6-2-19 Performance of Liquid Bulk Ships (Haldia)
(in days)

Sl. No.	Description	83/84	84/85	85/86	86/87	87/88
1.	No. of ships	226	258	347	322	307
2.	Total cargo handled ('000 Tonnes)	4,047	4,281	5,134	4,938	4,939
3.	Aveg. parcel size (Tonnes)	17,907	16,593	14,795	15,335	16,088
4.	Avg. output per ship day (Tonnes)	12,700	11,062	11,469	12,294	13,080
5.	Avg. pre-berthing time	1.38	1.82	1.39	1.10	1.13
6.	Avg. stay at berth	1.41	1.50	1.29	1.25	1.23
7.	Avg. working time	0.85	0.79	0.71	0.70	0.71
8.	Avg. non-working time	0.57	0.71	0.58	0.55	0.45
9.	Working/stay time ratio	0.60	0.53	0.55	0.56	0.58
10.	Avg. output per effective hour (tonnes)	878	875	866	913	944

While the average working time has remained stable in three recent years, the average non-working time has decreased gradually. The reasons for non-working time were "Waiting for sailing" = 73.0% and "Operation necessity" = 26.4% in 1986/87.

On the other hand, the main reason for pre-berthing waiting time was "Non-availability of suitable berth", comprising 62.8% in 1986/87.

Fig. A-6-1-3 shows the long pre-berthing time from Sandhead to the oil jetty on January 1988 due to the non-availability of the oil jetty, and bunching of vessel's arrival.

Table 6-2-20 below shows the ship performance of POL/Liquid ammonia, and phosphoric acid which was handled exclusively at the Figure Jetty in the last three years.

Table 6-2-20 Commodity wise Performance (Liquid Bulk)

Sl. No.	Description	86 / 87		87 /88		87 /88	
		a	b	a	b	a	b
1.	No. of ships	344	3	308	14	295	12
2.	Total cargo handled ('000 Tonnes)	5,115	19	4,857	80	4,846	93
3.	Avg. parcel size (Tonnes)	14,869	6,333	15,769	5,714	16,427	7,750
4.	Avg. output per ship day (Tonnes)	11,419	4,624	12,606	4,920	13,339	5,833
5.	Avg. pre-berthing time	0.79	-	1.14	0.21	1.14	0.86
6.	Avg. stay at berth	1.30	1.40	1.25	1.17	1.23	1.32
7.	Avg. working time	0.71	0.71	0.71	0.53	0.72	0.62
8.	Avg. non-working time	0.59	0.69	0.54	0.64	0.51	0.70
9.	Working / stay time ratio	0.55	0.51	0.57	0.45	0.59	0.47
10.	Avg. output per effective hour (Tonnes)	873	372	925	449	951	521

a: POL crude, POL products and Liquid NH_3

b: Phosphoric Acid exclusively handled at the Finger Jetty

Average output per effective hour of phosphoric acid increased remarkably during these years.

6-2-5 Suggestions

In order to realize the maximum utilization of the existing port resources, the necessary improvements are suggested based on the following three points of view:

(1) Technical,
(2) Personnel, and
(3) Communications.

(1) Technical

1) Lack of container handling equipment such as tractors/trailers, spreaders and heavy duty forklift trucks.

Matching the horizontal movement of containers at the yard with the cycle time of ship gear, Portainers and transfer cranes is the most important factor in order to increase the productivity of container handling.

The necessary equipment is proposed in another section considering the future throughput and the development plan.

The use of spreaders is a very efficient way to shorter the overall cycle time, and the necessary number of spreaders should be provided for stevedoring.

2) Lack of forklift trucks and attachments used for the handling of various types of cargo and pallets.

Utilization of pallets should be introduced to the greatest possible extent.

3) Establishment of a preventive maintenance system with sufficient spare parts.

4) Conventional dry bulk cargoes should be handled using grab slings with direct loading onto trucks.

5) Floating cranes should be provided for lifting heavy cargo in order to avoid the shifting of ships due to the non-availability of heavy duty shoreside cranes.

(2) **Personnel**

1) Lack of skilled laborers for mechanical cargo handling

Calcutta Port and Dock Workers Institute was set up in 1985 to teach modern port methods, particularly in the field of cargo handling. This Institute may play a significant role on this matter together with the Port Workers Training Scheme at Haldia.

2) Lack of safety control

During the site survey, it was observed that almost all the workers were working without helmets and gloves. The workers are actually barefoot and wear traditional light clothing which gives little or no protection. Such working conditions should be improved as soon as possible to avoid injuries.

(3) **Communications**

1) Lack of necessary communication exchange among the related parties such as shipping companies, steamer agents, stevedores and CPT.

At present, Ship Planning Meetings are held in advance of vessel arrival. Under this organization, a working group to improve productivity may be established in order to investigate ship working plans in detail based on the planning documents such as working schedules and sequence check lists.

Furthermore, the results of operations should be reviewed after the completion of the work in order to identify factors which hinder the smooth flow of cargo.

2) The working group could also function as an investigative organization, monitoring berthing and generally promoting the quick dispatch of ships.

6-3 Container Terminal Operation

The present situation of container cargo handling operation at Calcutta and Haldia is as follows.

(1) Calcutta

Table 6-3-1 shows the throughput by berth in TEUs from 1985/86 to 1987/88.

Table 6-3-1 Berth Throughput

Sl. No.	Berth No.	Throughput in TEUS		
		1985-86	1986-87	1987-88
1.	DNSD	19,329	17,682	16,988
2.	5NSD	11,650	14,575	15,552
3.	3KPD	8,895	8,679	8,260
4.	28KPD	-	*1,079	N.A.
5.	Total	39,874	42,015	40,800
6.	Percentage to Annual throughput	85.7	84.3	85.6

* From Dec. 1986

These four berths are allocated for handling containers and from the above figures it reveals that annual throughput at DNSD has decreased and that at 5NSD has increased in recent three years due to the construction work at DNSD.

The Container Terminal Project at DNSD which is now under way is summarized as follows:

(a) Civil works for a Container Park with 1,284 ground slots and roadways around it have already been executed and the remaining work is expected to be completed by September 1989.

(b) Civil works for a Container Freight Station of 9,000 sq. mts. and roadways around it are now under construction and the remaining work is expected to be completed by December 1988.

(c) Civil works pertaining to the Electrical Sub-Station, lighting and other ancillary works will be completed by September 1988.
Electrical works for the Electrical Station, power supply an distribution in the entire terminal complex are expected to be completed by December 1989.

(d) Other civil works such as drainage, roads, pavement, workshops, gates and water supply will be completed by September 1989.

(e) Procurement of container handling equipment viz. RTGs, prime movers, trailers, forklift trucks and mechanical spare parts and installation of the computer system will be executed using an ADB loan. The necessary agreement has been already finalised.

(f) The entire project is likely to be completed by March 1990.

The flow of container cargo handling operation at present is as follows:

1) Import

① Stevedores with stevedoring licenses and stevedores who are stevedores by virtue of Regulations perform the work of carrying goods from vessels in the port to the wharves, piers, quays or docks belonging to the Board of Trustees of the Port of Calcutta and any other works involved in stevedoring of vessels within the port.
They carry out the operations using gear owned or hired by them and employ dock workers who are registered in the register maintained by the Calcutta Dock Labour Board (CDLB).

② Shoreside container handling operation is generally carried out by stevedores using their own equipment and by CPT workers. CPT conducts empty container handling operation using its equipment when requested.

③ Delivery of containers to the consignees' premises including nominated warehouses, is carried out by private "public carriers" who get permits from the state governments. Some containers are delivered from the hook point to consignee directly.

④ Returning of empty containers from the consignees' premises to the private empty container depot or the CY in the terminal and delivery from the CY to the private container depot is done by public carriers.

⑤ Unstuffing of loaded containers is carried out at open storage yards by stevedores using their own equipment and by CDLB workers.

⑥ Unstuffed cargo is delivered into the transit shed by CPT using CPT equipment and CPT workers or directly to the consignees' premises by public carriers.

⑦ Break bulk cargo which is unstuffed from containers is delivered to the consignee by public carries.

The outline of the container flow of imports is shown in Fig. 6-3-1.

2) Export

① Empty containers are carried to the shipper's premises and/or nominated warehouse for stuffing from the CY or the private empty container depot by private trucking companies.

② Loaded containers are delivered to the CY by private trucking companies.

③ Break bulk cargo which will be stuffed at the open storage yard is carried into the transit shed or directly to the yard by public carriers.

④ Such cargo as jute products is carried by barge from the riverside factories to the wharf and unloaded by CPT with CPT equipment and workers on shoreside and then delivered into the shed.

⑤ Break bulk cargo in the shed is carried out for stuffing to the open storage yard by CPT with CPt equipment and CPT workers.

⑥ Stuffing of cargoes into containers is done at the open storage yard by stevedores with their own equipment and by CDLB workers.

⑦ Shoreside container handling operation is carried out by stevedores with their own equipment and CPT workers.

⑧ On board work for loading is carried out by stevedores with their own equipment and by CDLB workers.

⑨ Regarding tea exports from the ICD in Guwahati, empty containers are delivered there by railway intermodal transport.

The outline of container flow for exports is shown in Fig. 6-3-2.

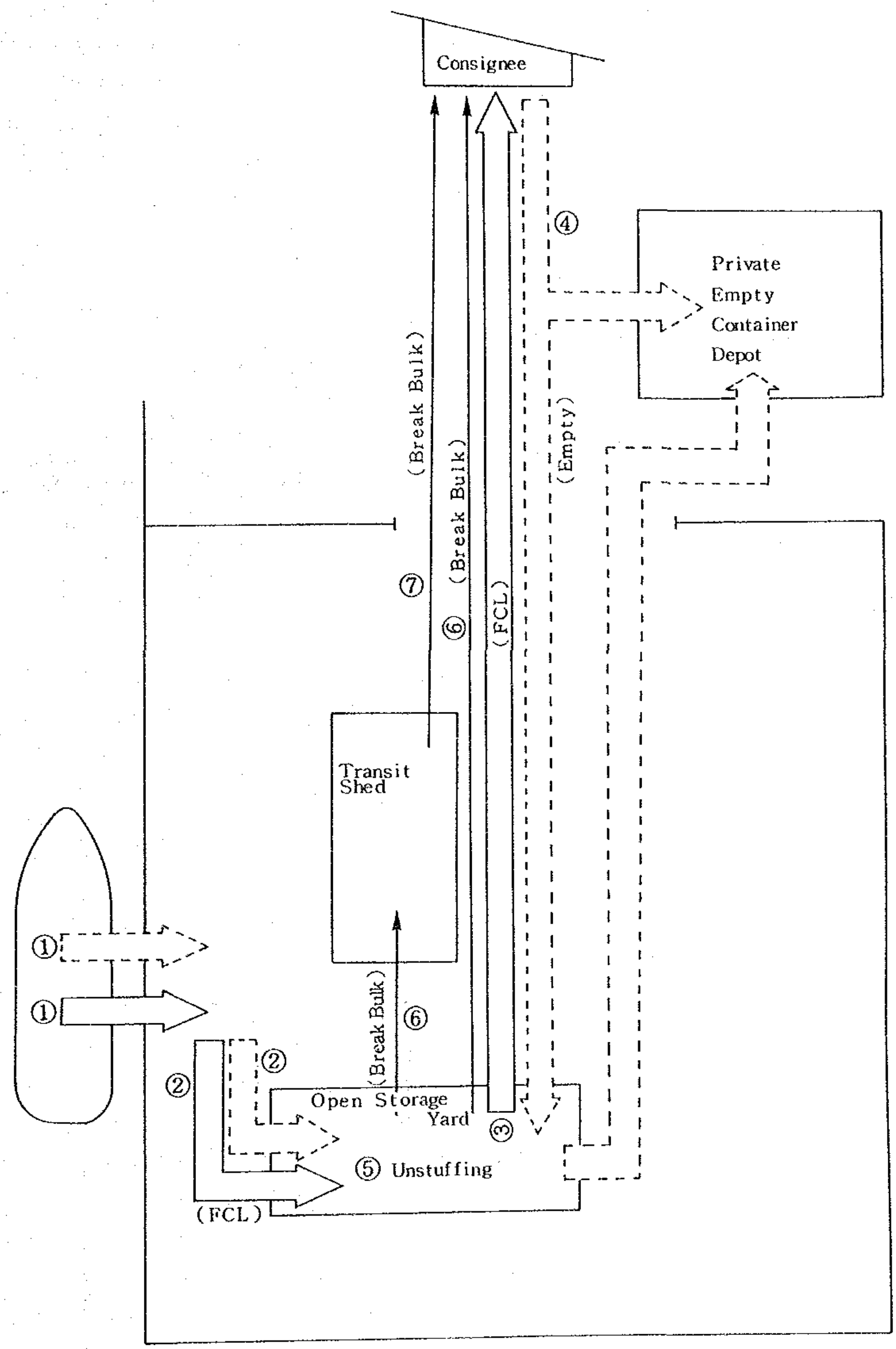


Fig. 6-3-1 Import Container Flow (Calcutta)

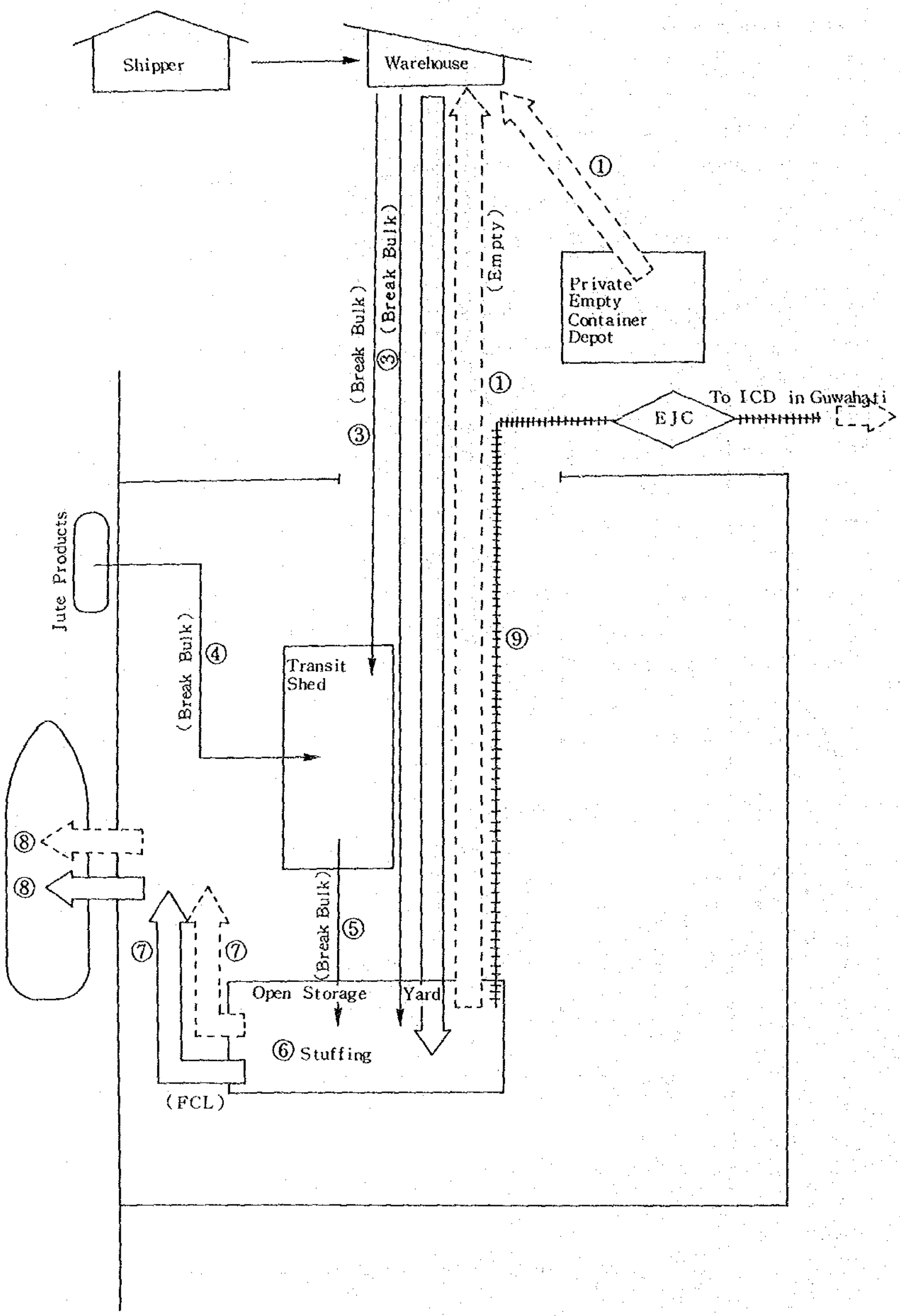


Fig. 6-3-2 Export Container Flow (Calcutta)

The present problems of container handling operation at Calcutta are mentioned in Section 6-2. However, the following items should be considered from the viewpoint of the future development of container handling operations.

(a) There is no fully autonomous unit which controls the entire flow of containers throughout the container terminal. The operation of the container terminal should ideally be established as a unified system in order to maximize the utilization of the premises and equipment which require a large amount of investment.

(b) The FCL containers, which should be delivered without unstuffing at the CY whenever possible in order to realize door-to-door transportation, are generally unstuffed in the port area. This causes traffic congestion in the terminal, cargo damage and the possibility of pilferage.

In this connection, the number of private warehouses nominated by the Customs authorities for stuffing and unstuffing increased from 150 in 1986/87 to 310 in 1987/88. Out of the total container traffic handled at Calcutta, about 15.2% was carried to/from the private warehouses. This policy should be developed further.

(c) Stuffing/unstuffing of containers is carried out at the Open Storage Yard in the Terminal. There is a transit shed in "D" NSD, but this shed does not function as the CFS. It was observed that unstuffed cargoes were drayed from the container side to the shed by forklift truck of CPT and lifted up to the second floor of the shed. The drayage of unstuffed cargoes not only decreases the cargo handling efficiency but also increases cost, cargo damage and traffic congestion in the terminal.

One CFS is under construction now and the present situation shall be improved in the near future.

(d) The handling of containers carried by SCI stevedored by CDLB has been executed exclusively using CPT equipment on Feb. 16, 1988. This was the first time that all these containers, including 40-foot loaded containers, were handled by the port's own equipment without the help of equipment from private contractors. It is said that the average output per hook per shift was 191 tonnes compared to 120 tonnes by the private stevedores with similar cargo.

Stevedoring is normally a contract between a shipping line or vessel owner/steamer agent and the stevedore and there are 27 licensed stevedores including CPT and CDLB at Calcutta. However, it is said that there is no serious competition which would keep the stevedoring rate at a reasonable level.
From the viewpoint of fair competition, this trial may have a significant impact on the future situation of stevedoring at Calcutta.

(2) Haldia

Handling of containers through the intermodal transport at Haldia during the year 1986/87 increased remarkably compared to the previous year. A volume of 10,300 TEUs, which comprises 67% of the total container traffic, was transported by Inland Railway Transport (5,134 TEUs, 50%), Inland Road transport (4,949 TEUs, 48%) and IWT. The volume of the intermodal transport handled by Inland Railway Transport reached about 7 times that of the previous year.

The flow of the container handling operation at Haldia is as follows:

1) Import

① Containers are discharged using both quay side gantry crane and the ship gear operated by the CPT workers. There is no Dock Labour Board at Haldia.

② Loaded containers are moved by the port tractor/trailer from ship side to the Container Parking Yard where the transfer crane is located and stacked 2.5 high on the yard by the crane which is also operated by the CPT workers. Private trucking companies are also hired for the movement of containers between the hook point and the yard by the shipping company or its agent.

③ Some containers are moved to the Open Storage Yard.

④ FCL containers are delivered to the consignees' premises by private trucking companies. Regarding the railway transport, FCL cargo which is mostly for projects is loaded on the wagon by transfer crane and transported to the project sites. Unstuffed containers at the site are carried by rail to the terminal.

⑤ Unstuffing is carried out mainly at Open Storage Yard and in the Unstuffing zone beside the Container Parking Yard by CPT workers.

⑥ Unstuffed cargo is delivered to the consignees' premises by private trucking companies.

The outline of import container flow is shown in Fig. 6-3-3.

2) Export

① Empty containers are delivered by rail to the ICD, Amingaon, stuffed there and carried by rail in FCL to the Container Parking Yard.

② Private trucking companies carry empty containers to the shippers' premises/bonded warehouse.

③ Then the loaded containers are returned to the Terminal.

④ Break bulk cargoes are carried by private trucking companies to the Open Storage Yard and stuffing zone beside the Container Parking Yard.

⑤ These cargoes are stuffed there by CPT workers and using CPT equipment as well as by the private equipment at the Open Storage Yard.

⑥ Export containers are delivered to the quay side by the CPT equipment and workers. Private trucking companies are also hired for the transportation by the shipping company or its agent when CPT equipment are not sufficient to cater to the requirement.

⑦ Then, containers are loaded onto the vessels using both the gantry crane and ship gear.

The outline of container flow for export is shown in Fig. 6-3-4.

The present problems of container handling at Haldia are afore mentioned in Section 6-2.

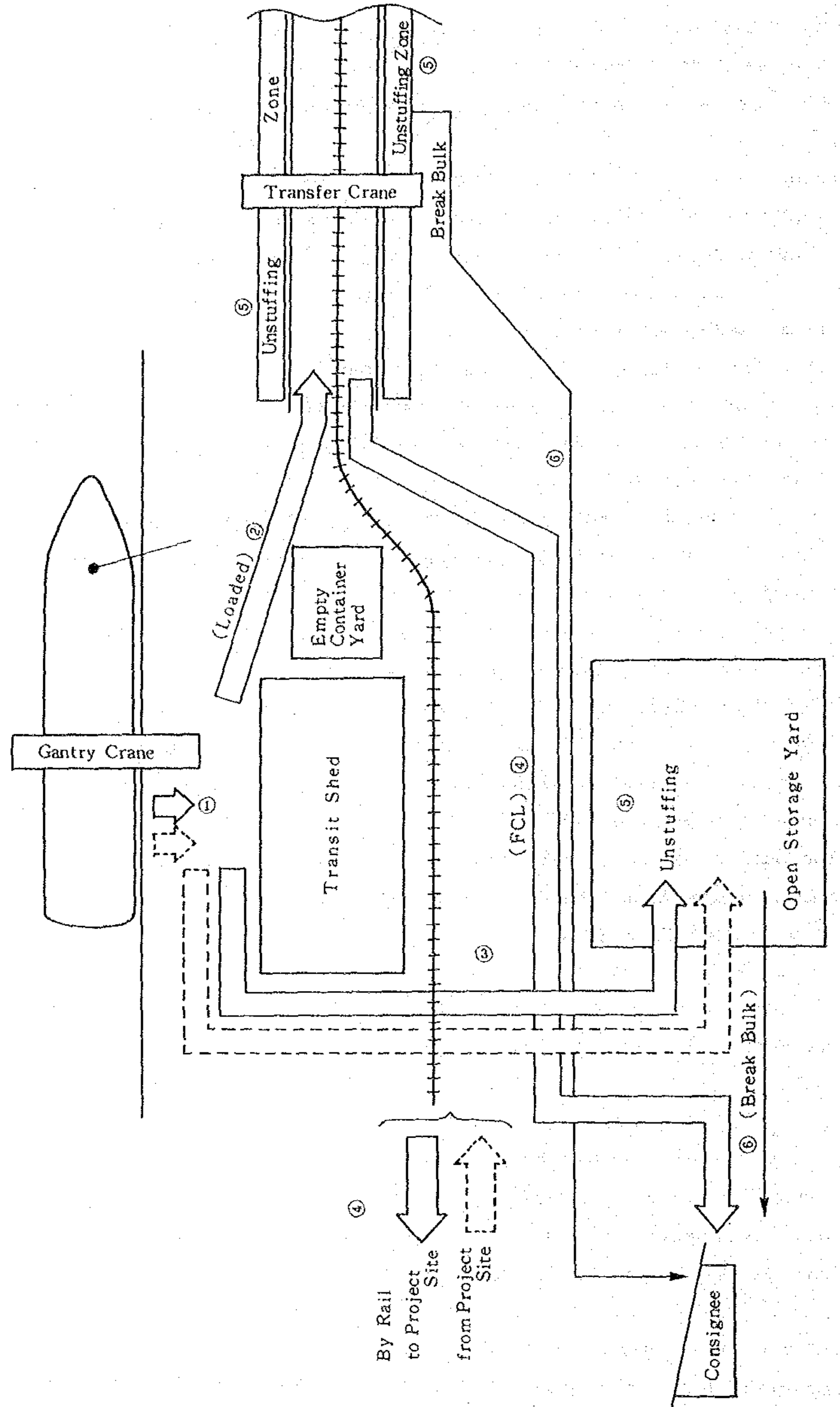


Fig. 6-3-3 Import Container Flow (Haldia)

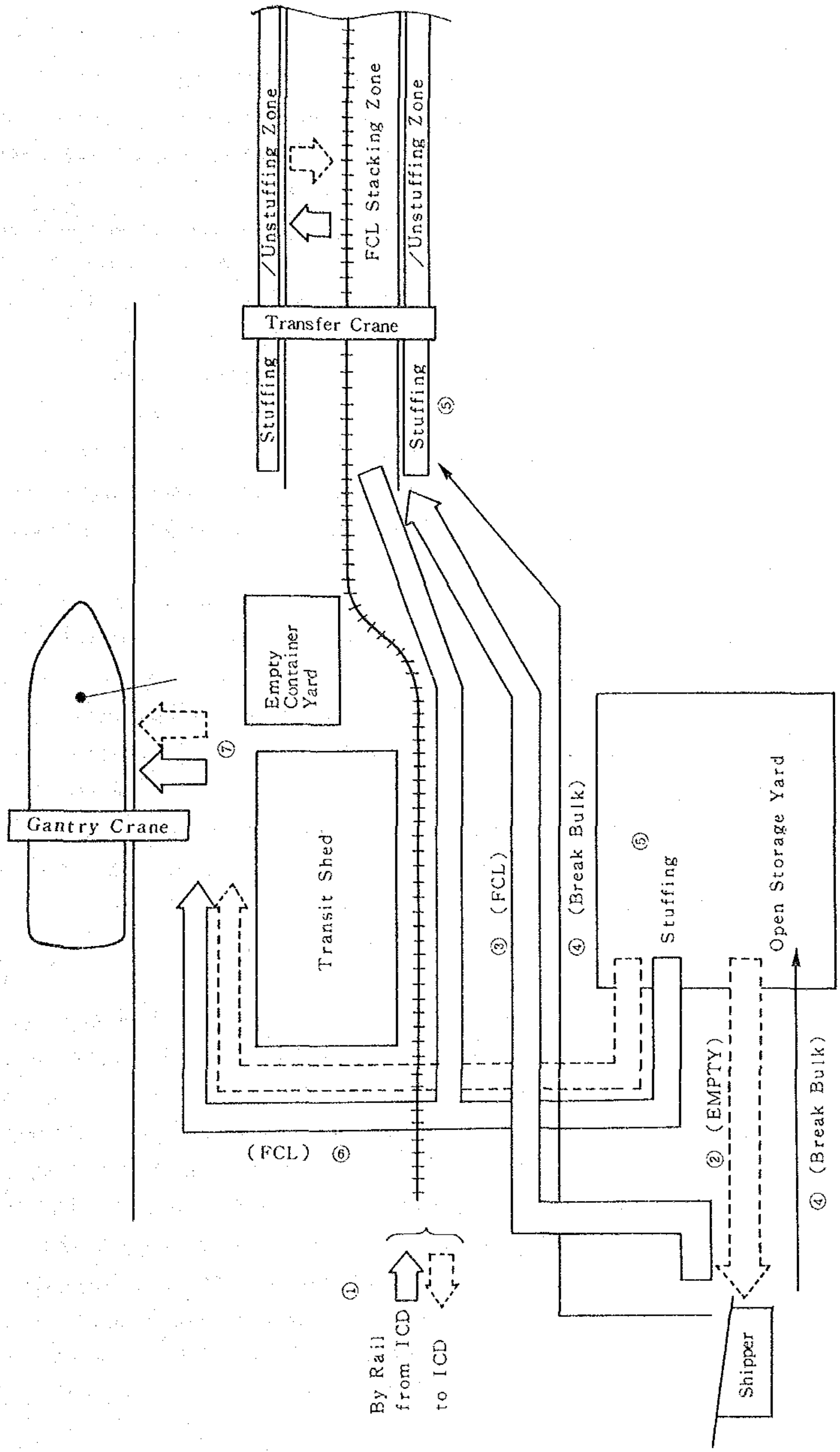


Fig. 6-3-4 Export Container Flow (Haldia)

6-4 Documentation Flow

Documentation flow related to import procedures is outlined below and the flow of documents for import and export are summarized in Fig. 6-4-1 and Fig. 6-4-2.

The port procedures for import are classified into the following three stages.

(a) Payment of basic port charges

(b) Filing of delivery documents

(c) Gate delivery

(1) Payment of Basic Port Charges

Import cargo may mainly be classified into four categories irrespective of whether it is landed in break bulk form or in containers:

(a) General Cargo

(b) Heavy lifts

(c) Hazardous Cargo and

(d) Bulk.

i) The following documents are to be submitted at the Collection Office:

(a) Jetty "Challan"

(b) The paid, endorsed or note pass duplicate Bill of Entry.

(c) The original Bill of Loading duly endorsed and the Steamer Agent's Delivery Order.

(d) Shipper's Invoice and cargo specifications.

(e) Freight lists (if required).

ii) If the documents are in order, some parties pay the necessary charges to the Cashier in cash. A debit voucher is attached to the delivery documents in case of parties with a registered deposit. The delivery documents are then made over to the Licensed "Sircar".

iii) In the case of heavy lift packages weighing less than 4,000 kgs, a Hoisting application has to be filed along with the Jetty Challan. All operational and other charges are borne by the consignees. In the case of heavy lift packages weighing 4,000 kgs and above, Landing charges have to be paid by Steamer Agents for which a separate marine Challan is also submitted.

iv) The additional charges for hazardous cargo are attached at the landing shed at the time of delivery.

v) The weight and dimensions of import consignments must be decleared by the party and the weight and dimensions are checked by the CPT for their own satisfaction.

(2) Filing of Delivery Documents

i) The following delivery documents are to be field by the licensed Jetty Sircar to the Head Shed Clerk in the landing shed:

(a) Jetty Challan - Along with the Marine Challan in the case of heavy lift cargo weighing 4,000 kgs and above.

(b) Bill of Entry (Duplicate)

(c) Bill of Lading (Original)

(d) Delivery Order

ii) The Head Shed Clerk checks the documents, registers them, makes over duplicate copy of Bill of Entry to the Jelly Sircar and passes over the other documents to the relative delivery counter.

iii) The Jetty Sircar makes out the Appraisement Ticket, which is countersigned by the Head Shed Clerk and the Customs Appraiser, and presents it to the Shed Appraising Clerk. The upper portion of the ticket and the Bill of Entry are returned to the party.

iv) After getting his cargo passed out of Customs control, the party presents the Bill Entry to the Counter Clerk. Port charges, if any, are recovered by the Counter Clerk at this stage.

(3) Gate Delivery

i) The Jetty Sircar makes out the Shed Delivery Order and presents it to the Counter Clerk, who passes it on to the Jetty Challan and obtains the Sircar's signature. The Clerk makes out the Jetty Gate Pass and hands it over together with the Bill of Entry and the Shed Delivery Order to the Sircar.

ii) The Sircar fills in the Loading Permit in duplicate and get the Counter Clerk's signature on it. One copy is retained by the Clerk and the other is returned to the Sircar, who hands over the Permit to the driver of the cart/lorry. The Sircar also makes out the Cart Ticket and hands it over along with the Loading Permit, the Shed Delivery Order, the Gate Pass and the Bill of Entry to the Delivery

Clerk.

iii) After completion of loading, the Delivery Clerk checks the lorry and the relative documents. A checker is present at the time of loading when requested by the consignee so as to certify that the cargo is properly loaded.
However, the Gate Warder also checks the cargo which has been checked by the Checker.

iv) After checking that the cargo is covered by the documents, the Gate Warder signs on the Loading Permit and delivers one copy to the C.I.S.F. personnel at the gate authorising them to let the cart/lorry pass.

Table 6-5-1 below shows the necessary documents for import corresponding to the oforementioned three stages of the port procedures.

Table 6-5-1 Necessary Documents for Import Procedures

Stage / Document	(a)	(b)	(c)
1. Jetty Challan	o	o	
2. Bill of Entry	o	o	o
3. Bill of Lading	o	o	
4. Invoice	o		
5. Delivery Order	o	o	
6. Appraisement Ticket		o	
7. Shed Delivery Order			o
8. Jetty Gate Pass			o
9. Loading Permit			o
10. Cart Ticket			o

The Jetty Challan functions as a basic document in import port procedures and the Jetty Challan, the Bill of Entry, the Bill of Loading and the Delivery Order are surrendered at least twice to different CPT sections. Since these procedures are very cumbersome they should be improved to facilitate streamlining of documentation flow.

In this connection, CPT has simplified the existing system of documentation in the form of doing away with the submission of Bill of

Lading/Indemnity Bond and instead accepted the Agent's Delivery Order, formation of Revised Procedure for delivery from 2/3 sheds and non-checking of export cargo at the gate, etc.

There are four CPT Collection Offices, viz., Central Collection Office at Calcutta Jetty, KPD, NSD and New Traffic Building and the first is opened from 10 AM to 2:30 PM on weekdays and 10 AM to 11:30 PM on Saturdays. The latter three offices are open from 10:30 AM to 3 PM on weekdays and from 10:30 AM to 12 noon on Saturdays. After normal working hours, only Calcutta Jetty Collection Office accepts documents etc. with a late fee of RS 10 per Jetty Challan from 3 PM to 7 PM on weekdays and 12 Noon to 5 PM on Saturdays.

It is convenient for the users that the four offices are located near each site. However, the working hours are much too short except at Calcutta Jetty. As regards office hours, it has been started as a trial system till 5 PM at Calcutta Jetty recently.

Regarding the Customs formalities, there are many documents necessary for the Customs clearance along with CPT. Therefore, co-operation between the two authorities should be promoted so as to simplify the procedures related to import/export.

In the case of Haldia, There is no Collection Office, and both Import Section and Export Section which are available on Sundays have been established at G/C berth with opening hours of 9 AM to 5 PM instead. Ad hoc port charges are paid based on the Manifest in advance and they are adjusted later based on the processed Bill of Entry.

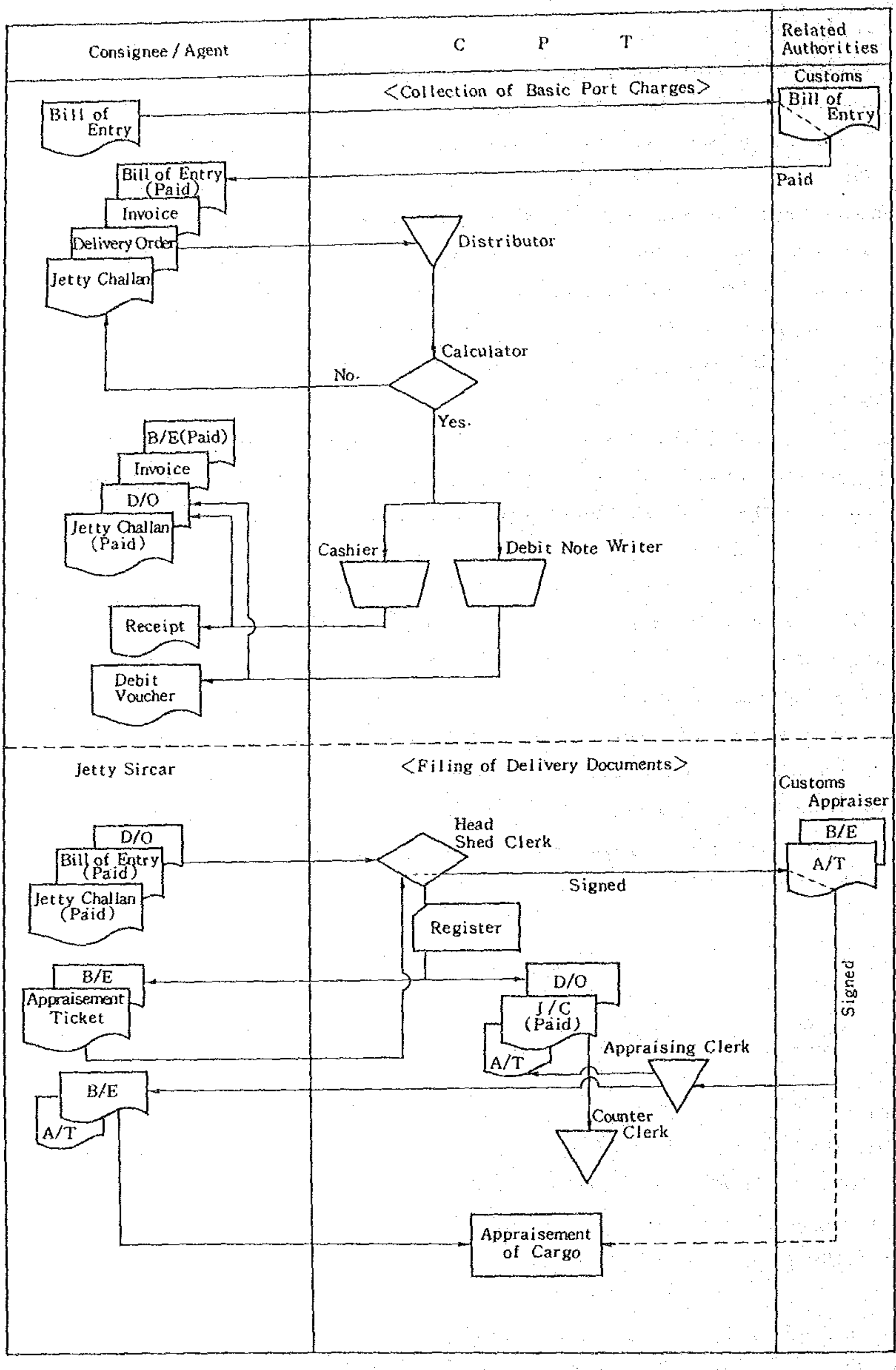


Fig. 6-4-1 Documentation Flow for Import

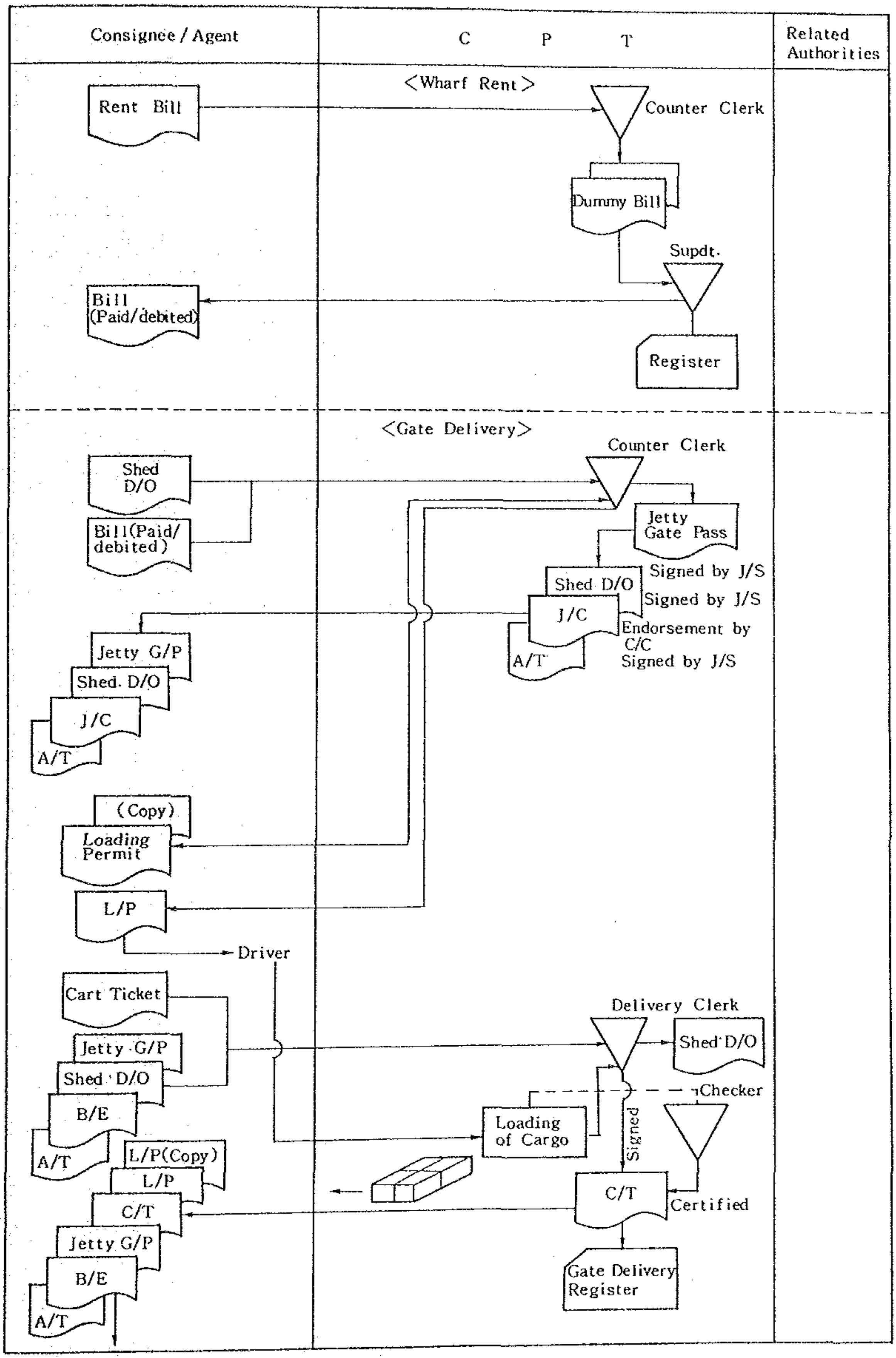


Fig. 6-4-1 Documentation Flow for Import (Contd.)

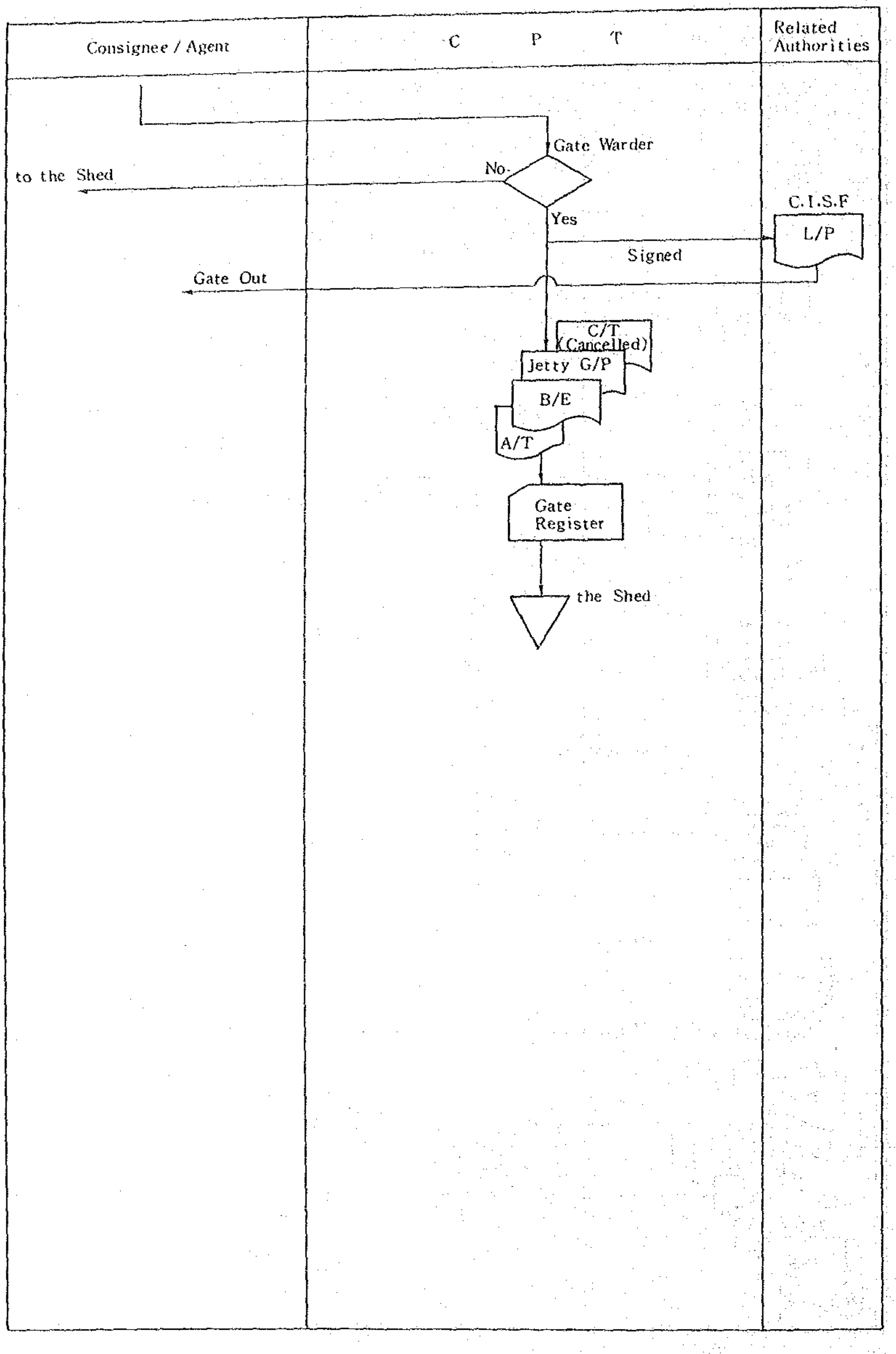


Fig. 6-4-1 Documentation Flow for Import (Contd.)

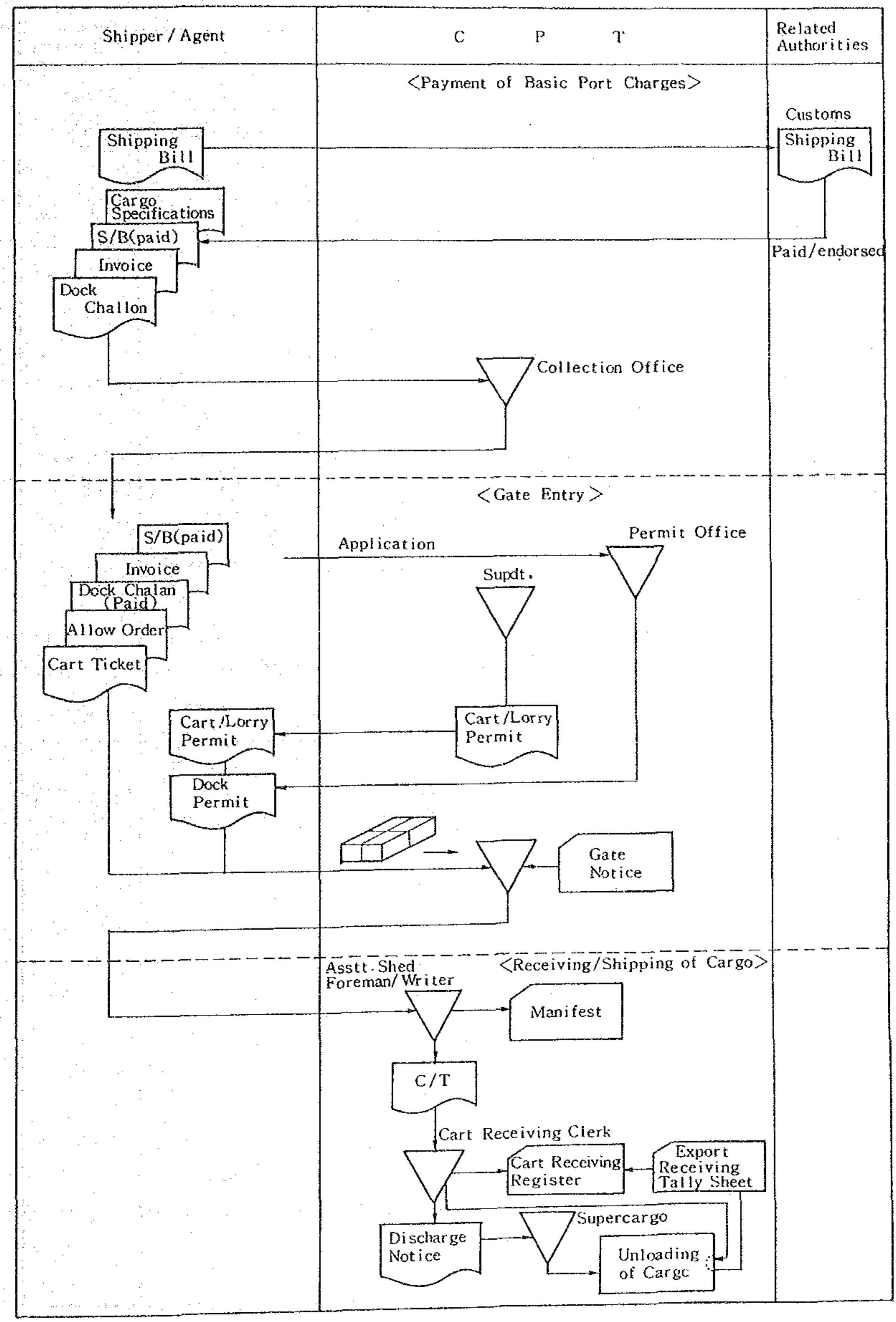


Fig. 6-4-2 Documentation Flow for Export

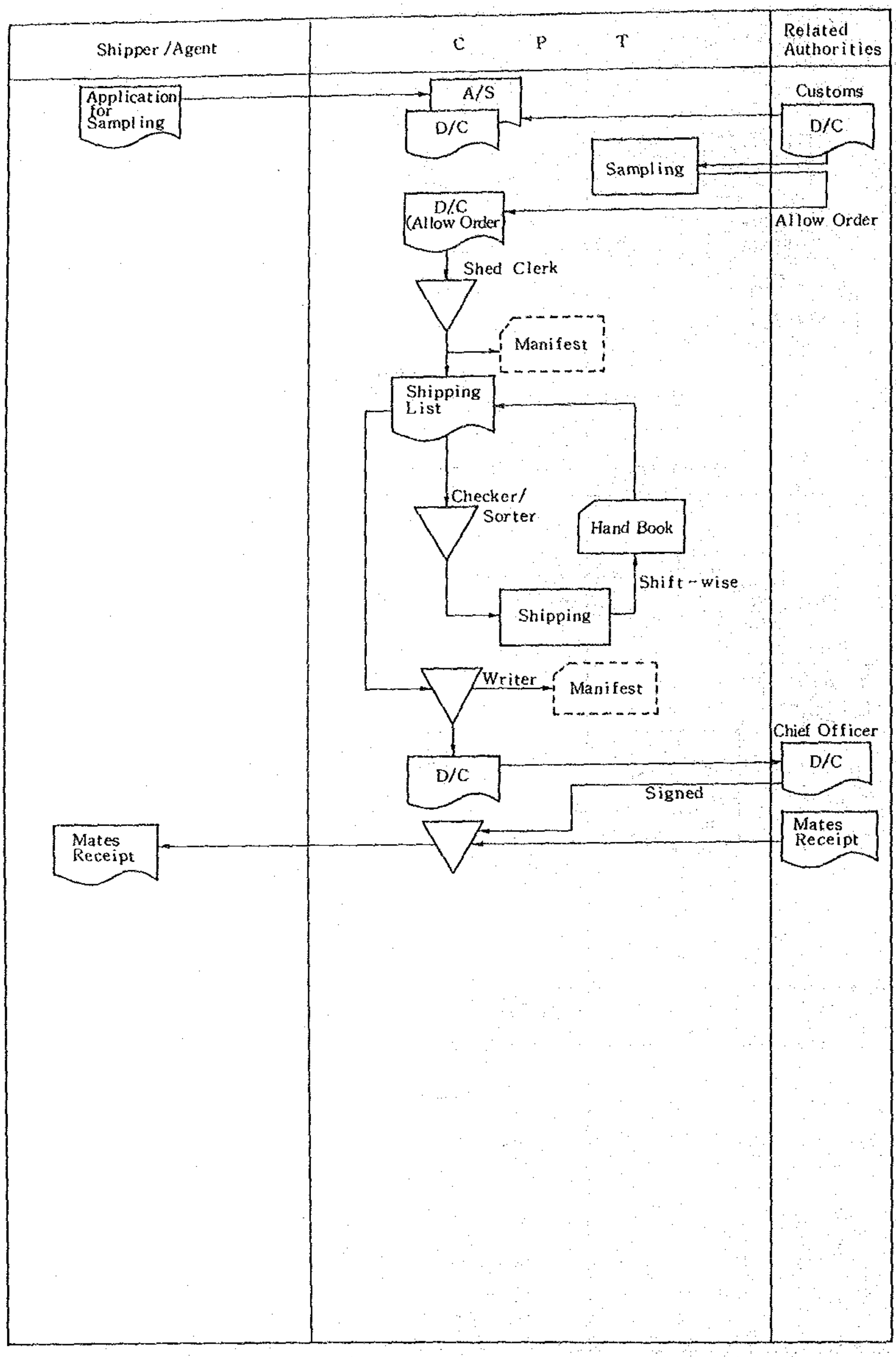


Fig. 6-4-2 Documentation Flow for Export (Contd.)

6-5 Communication System

The breakdown of communication system related to port operation deals the port a fatal blow. There are so many parties concerned for import/export information flow such as shippers/consignees, forwarding agents, shipping companies, banks, steamer agents, stevedores, trucking companies and other ancillary parties along with CPT and the Customs. Therefore, reliable information exchange system among these parties should be certainly provided in order to maintain scheduled servicing and efficient cargo handling operation.

According to the Seventh Plan, the improvement component of communication system would consist of replacing life-expired and worn out equipment, ducting of cables, automatisation of manual exchanges and computalisaion of services in Metropolitan cities etc. And the upgradation of the network in the four Metropolitan cities of Delhi, Bombay, Calcutta and Madras is included under this component.

In this connection, the breakdown of telecommunicaion system often occurred in Calcutta due to the heavy rain and communication network between Calcutta and Haldia was very poor.

The mid-term appraisal of the Seventh Five Year Plan points out that large users are planning for their own dedicated communication facilities based largely on imported equipment and some of these users include railways, defence, banks, power stations and enterprises in the steel, coal and oil industries.

Since the circumstances surrounding the port will be charged rapidly, the proper correspondence should be required to the port so as to improve the present condition of communication system.

Communication system is devised into following four categories:

(a) Internal

(b) Local

(c) National

(d) International

The latter three categories should be developed as the infrastructure by the Ministry concerned and the first should be improved by the port itself.

6-6 Financial Performance

Table 6-6-1 below shows the past financial performance of CPT.

Table 6-6-1 Financial Performance of CPT

Summary of Income Statement

(in Million Rs)

Description	1983/84	1984/85	1985/86	1986/87	1987/88
Operating Revenue	1,134	1,441	1,367	1,503	1,542
Working Expenses	936	1,015	1,155	1,219	1,351
Depreciation	72	78	82	82	78
Total Operaing Expenses	1,008	1,093	1,237	1,301	1,429
Operating Income	126	348	130	202	113
Non-Operating Income	50	105	99	177	134
Interest on Long Term Debt	81	84	87	97	99
Other Non-Operating Experses	127	200	160	167	205
Net Income (Deficit)	(32)	169	(18)	115	(57)
Working Ratio (%)	83	70	84	81	88
Operating Ratio (%)	89	76	90	87	93

Summary of Balance Sheet

(in Million Rs)

Description	1983/84	1984/85	1985/86	1986/87	1987/88
Assets					
Fixed Assets					
Capital Assets	3,188	3,501	3,606	3,638	3,638
Depreciation	909	984	1,064	1,145	1,191
net Fixed Assets	2,229	2,517	2,541	2,493	2,447
Work in Progress	629	414	427	568	658
Investment	107	109	109	101	96
Current Assets	1,306	1,675	1,563	1,694	1,865
Others					
Un-covered Revenue Deficit	103	69	169	197	423
Deferred Revenue Expenditure	21	14	7	-	-
Capitalized debt charges	1,214	1,331	1,447	1,564	1,683
Deferred charges	8	5	5	4	4
Total Assets	5,617	6,133	6,269	6,622	7,176

Liabilities					
Capital Reserves	584	782	982	1,199	1,383
Other Reseves and Surplus	161	205	220	248	273
Capital Debt	3,762	3,963	4,053	4,219	4,311
Current Liabilities	1,110	1,183	1,014	956	1,209
Total Liabilities	5,617	6,133	6,269	6,622	7,176
Return on Net Fixed Asstes (%)	2.2	10.1	2.7	8.5	1.7

Regarding the capital expenditure for the comprehensive scheme for the improvement of river droughts in the Hooghly, a part of the cost is recoverable from the Government of India.

The capitalized interest with regards the projects of "Dredging of the Shipping Channel leading to Haldia" and Haldia Dock which were closed on March 3rd, 1980 and the expenditure up to March 3rd, 1980 transferred to Block A/C. in 1980/81. From 1980/81 the expenditure on the above sheme in the shape of maintenance dredging is being charged to revenue under Haldia, 90 % which is recoverable from the Government by way of contribution.

The Working Ratios of the past 5 years exceeded 80 % except 1984/85.

The Operating Ratios also exceeded 80 % except 1984/85. The Rates of Return on Net Fixed Assets were less than 10 % except 1984/85.

However, CPT increased the Scale of Rates on March 10, 1988 part of which were changed again on May 5, 1988. Therefore, it is expected that the financial performance of CPT will be partly improved from 1988/89 onward.

Chapter 7 Future Trends of Shipping Technology

7-1 Future Trends of Shipping Technology

At the open forum held in 1988 in Seoul, Dr. Richard O. Goss, professor, Institute of Maritime Economics, University of Wales Institute of Science & Technology, UK presented a vision of World Shipping to the Year 2000. According to his presentation, the great change in maritime technology in the future will be as follows.

Over the past thirty years, we have experienced the revolution of containers, of exploiting the economies of scale in large ships and of a variety of specialized ships like ro-ro ferries and pure car carries.

At the moment it seems likely that the next set of such changes will involve the impact of information technology and electronic data interchange. It is likely that within a few years, container ships' cargoes will be cleared through Customs before the ship has even arrived in port-though with the authorities still having the right to examine what they please. Similarly, it may come to be common for ships' documents to be examined at long range and through a central computer rather than by a numbers of officials going on board at each port.

The average ship size is believed to be increasing over the next decade or so, partly due to volumes of trade and port improvements like dredging, but also as an economic reaction to a continued improvement in cargo handling rates.

Improvements in the fuel economy of ships are believed likely to continue, but may not be so dramatic. The introduction of nuclear-powered merchant ships is not expected.

Turning to navigation, the Global Positioning System (GPS) will provide more accurate navigation and track-keeping at sea and, since it seems likely to become very cheap, it may be adopted by the majority of ships. And there will be some extension of Vessel Traffic Management Systems (VTS). The use of radar and satellite observations, plus a certain amount of local determination, may do a great deal to improve the current practices with respect to search and rescue (SAR).

(1) Oil Tankers

1) Present Vessel Size Distribution

a) Proportion of Classified Vessel Size

As Fig. 7-1-1 shows, the proportion of oil tankers below 50,000 DWT is over half of the total number of oil tankers, viz 53.08 %. But the proportion of the freight space below 50,000 DWT tankers is only 17.2 % of the total DWT. The proportion of oil tankers between 250,000 DWT and 300,000 DWT is only 8.14 % of the total number of oil tankers, but the proportion of the freight space of these tankers is 26.2 % of the total DWT.

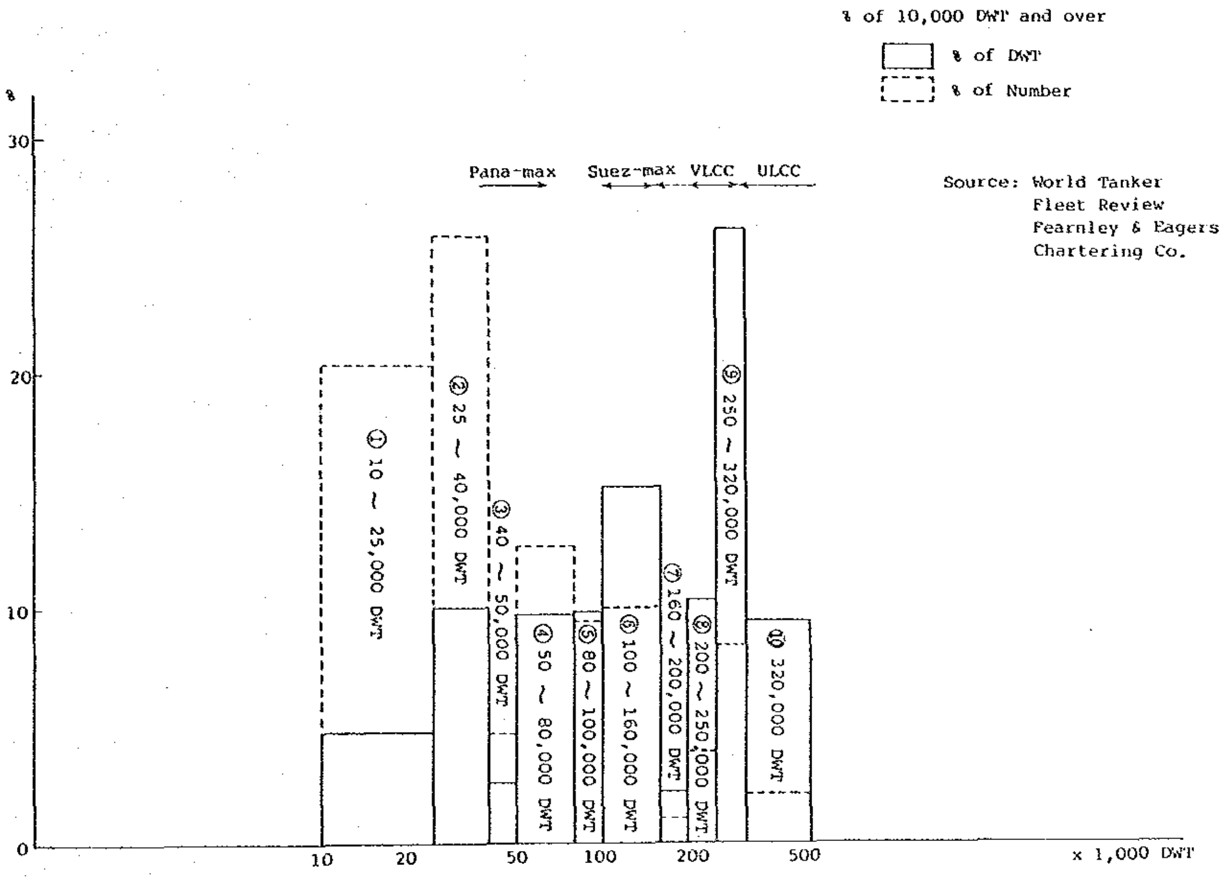


Fig. 7-1-1 Present Vessel Size Distribution of Oil Tankers

Generally speaking, the oil tankers between 200,000 DWT and 300,000 DWT are called as VLCC (Very Large Crude oil Carriers) and the proportion of VLCC is 11.92 % of the total number of oil tankers, but the proportion of freight space is 36.5 % of the total DWT. The oil tankers of 300,000

DWT and more are called as ULCC (Ultra Large Crude oil Carriers). The proportion of ULCC is only 2.05 % of the total number of oil tankers, and the proportion of freight space is 9.5 % of the total DWT.

The so-called Suez-max tankers are the tankers between 100,000 DWT and 150,000 DWT. The proportion of oil tankers over Suez-max is 14.96 % of the total number of oil tankers, and the proportion of freight space is 48.1 % of the total DWT. The so-called Pana-max tankers are around 65,000 DWT. The proportion of oil tankers over Pana-max is 34.33 % of the total number of oil tankers and the proportion of freight space is 71.91 % of the total DWT.

The above proportions are based on the data from Fearnley. The data contain all oil tankers over 10,000 DWT. On the other hand, the Lloyd's Statistical Table treats all oil tankers over 100 GRT. Fig. 7-1-2 shows the present vessel size distribution of oil tankers based on the Lloyd's Statistical Table. The proportion of oil tankers below 10,000 DWT is 58.48 % of the total number of oil tankers, but the proportion of freight space is only 4.32 % of the total GRT.

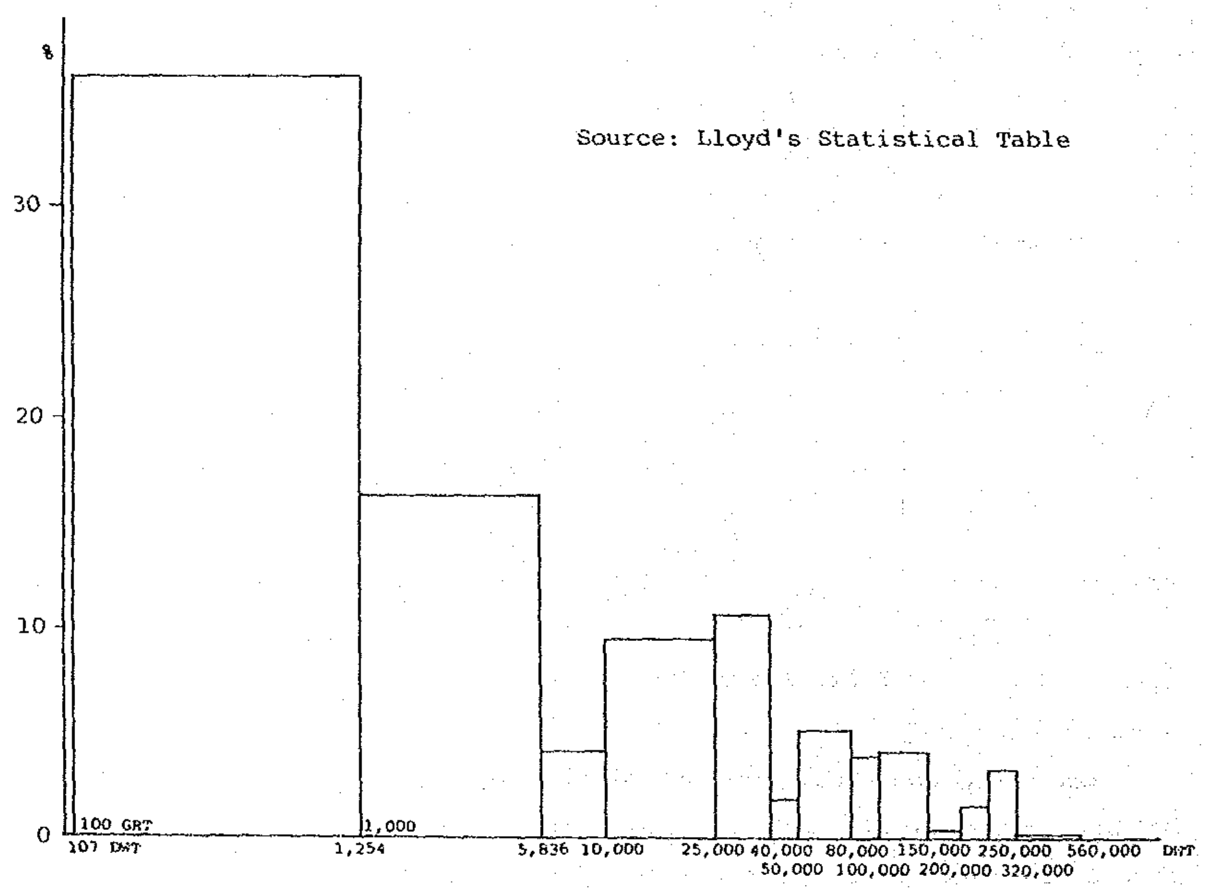


Fig. 7-1-2 Present Vessel Size Distribution of Oil tankers

b) Dimensions of Vessel Size

From the report of "Analysis on the Interrelations among the Several Dimensions of Ships" (hereinafter referred to as the PHRI report) the following formulae are obtained.

$\log L = 0.643 + 0.364 \log DWT$ (< 5,000 DWT) - ①

$\log L = 0.925 + 0.302 \log DWT$ (≥ 5,000 DWT) - ②

$\log d = -0.337 + 0.312 \log DWT$ (< 5,000 DWT) - ③

$\log d = -0.174 + 0.267 \log DWT$ (≥ 5,000 DWT) - ④

$\log B = 0.109 + 0.281 \log DWT$ (< 5,000 DWT) - ⑤

$\log B = -0.055 + 0.326 \log DWT$ (≥ 5,000 DWT) - ⑥

where L: Length over all of vessels (m)

d: Full loaded draft (m)

B: Breadth of vessels (m)

The standard deviations and the coefficients of correlation of the above respective formulae are as follows.

Table 7-1-1 Standard Deviations and Coefficients of Correlation

No. of formula	σ	r
①	0.030	0.955
②	0.014	0.990
③	0.029	0.941
④	0.022	0.968
⑤	0.029	0.930
⑥	0.044	0.920

By using these formulae, the dimensions of oil tankers can be calculated as follows.

Table 7-1-2 Calculated Dimensions of Oil Tankers

	D W T	G R T	L	d	B
①	10,000	6,561	135.8 m	7.83m	17.74m
②	25,000	15,230	179.1	10.00	23.92
③	40,000	23,458	206.5	11.34	27.88
④	50,000	28,797	220.8	12.04	29.98
⑤	80,000	44,355	254.5	13.65	34.95
⑥	100,000	54,450	272.2	14.49	37.58
⑦	160,000	83,866	313.8	16.42	43.81
⑧	200,000	102,955	335.7	17.43	47.11
⑨	250,000	126,388	359.1	18.50	50.67
⑩	320,000	158,574	386.9	19.76	54.91
⑪	565,000	267,382	459.3	23.00	66.09

The following table shows sample dimensions of existing oil tankers.

Table 7-1-3 Dimensions of Existing Oil Tankers

	DWT	GRT	L	d	B	Name	
①	10,531	6,480	128.38 m	8.25 m	19.80 m	Japan Tsuna 2	79.5
①'	10,913	6,274	130.50	8.25	18.00	Tomiwaka	75.9
②	27,208	15,994	178.50	10.27	25.00	Eiyu	74.5
③	36,760	23,123	170.50	11.20	30.00	Crown Seki Oak	81.3
③'	35,145	26,167	174.83	11.01	30.00	Kinokawa	81.9
④	55,202	33,032	210.30	12.41	32.25	Raiko	77.3
④'	53,143	36,003	226.5	11.43	32.20	Ocean Swallow	80.9
⑤	83,131	54,711	237.7	12.73	42.00	Toyu	81.5
⑥	99,940	51,719	243.0	14.92	40.00	Asia No. 2	75.7
⑥'	110,803	61,170	257.0	15.98	40.00	Teiko	72.9
⑦	171,101	88,886	295.1	18.88	44.50	Shoho No. 2	76.11
⑦'	177,528	109,297	300.0	16.50	52.00	Nitten	82.8
⑧	212,708	110,037	315.75	19.33	50.00	Kyoei	71.4
⑨	250,090	130,608	336.85	19.74	53.60	Takamiya	72.12
⑩	366,492	184,855	347.00	27.07	54.50	Nisseki	71.9
⑪	476,628	238,517	378.85	28.20	62.00	Nissei	75.6

The following table shows the trend of oil tanker dimensions.

Table 7-1-4 Trend of Very Large Tankers around the World

Name	Nation of Registry	Completion Year	DWT	La(m)	B(m)	d(m)	Velocity	Main Engine	Crew
World Unity	Greece	1952	31,745	199.0	26.3	10.5	15.5	T 13,750HP	-
Tina Onassis	Liberia (US)	1953	45,230	236.4	29.2	11.5	16.5	T 17,000HP	-
Universe Leader	"	1956	85,515	260.5	38.2	14.0	14.5	T 19,250HP	-
Universe Apollo	"	1959	114,356	289.5	41.3	15.5	16.0	T 25,000HP	57
Nissho Maru	Japan	1962	130,250	291.0	43.0	16.5	16.5	T 28,000HP	50
Tokyo Maru	"	1965	151,258	306.5	47.5	16.0	16.5	T 30,000HP	29
Idemitsu Maru	"	1966	209,413	344.2	49.8	17.6	15.9	T 33,000HP	32
Universe Ireland	Liberia	1968	326,000	346.0	53.3	24.1	14.6	T 37,400HP	51
Nisseki Maru	Japan	1971	372,698	346.7	54.5	27.0	15.0	T 40,000HP	31
Globtik Tokyo	U K	1972	477,000	378.9	62.0	28.0	14.3	T 45,000HP	38
Nissei Maru	Japan	1975	484,337	378.9	62.0	28.2	14.3	T 45,000HP	34
Batillus	France	1976	550,001	414.2	63.0	28.5	16.0	T 64,800HP	-
Pierre Guillaumat	"	1977	555,031	414.2	63.0	28.6	16.8	T 65,000HP	-
Sea Wise Giant	Liberia	1980	564,763	440.0	68.8	24.6	15.2	T 50,000HP	-

in 1988

The following table shows the dimensions of very large tankers in Japan.

Table 7-1-5 Very Large Tankers in Japan

Name	Owner's Name	GRT	DWT	La(m)	B(m)	D(m)	d(m)	Velocity (knot)	Engine (PS)	Comp. Year	
Nissei Maru	Tokyo Tanker	238,517	484,276	378.85	62.00	36.00	28.20	14.3	T 45,000	75.06	29
Sunshine Leader	Yoko Kaiun	134,555	274,137	337.05	54.50	27.00	21.03	16.0	T 40,000	75.10	-
Kyuseki Maru	Shinwa, Nippo, Kyuseki	145,661	264,164	321.47	58.00	26.37	19.84	13.9	D 23,720	87.9	42
Shuho Maru	Iino Fudosan	135,891	262,138	337.06	54.50	27.00	20.35	13.0	D 23,200	75.08	30
Kaku Yo Maru	Iku yo Senpaku	135,117	259,999	331.50	56.00	26.40	19.73	15.8	T 40,000	75.06	-
Tokitsu Maru	Nihon Yusen	129,511	259,762	331.50	54.80	26.40	20.50	13.1	D 26,400	76.03	30
Ise Maru	Sho yo Kaiun	134,684	258,674	337.00	54.50	27.00	20.00	13.4	D 24,000	74.10	29
Tokyo Maru	Tokyo Tanker	145,575	258,374	321.47	58.00	29.50	19.52	14.0	D 22,400	86.10	-
Nisseki Maru	"	149,537	258,094	330.00	60.00	29.70	19.60	14.0	D 23,640	88.4	-
Idemitsu Maru	Idemitsu Tanker	147,568	258,090	322.50	60.00	28.80	19.24	14.0	D 21,150	85.10	40

in 1988

The dimensions of oil tankers below 10,000 DWT can be calculated as follows.

Table 7-1-6 Calculated Dimensions below 10,000 DWT

	GRT	DWT	L	d	B
①	100	107	24.08 m	1.98 m	4.78 m
②	1,000	1,254	59.00	4.26	9.54
③	4,000	5,836	115.44	6.79	14.89
④	10,000	15,817	156.00	8.85	20.60

2) Trend of Oil Tanker Size

As Table 7-1-4 shows, before 1959 maximum oil tanker size was below 100,000 DWT, but the Universe Apollo of 114,000 DWT was commissioned in 1959. Being confronted with the close of the Suez Canal in 1967, the maximum oil tanker size exceeded 200,000 DWT in 1996, 300,000 DWT in 1968, and 400,000 DWT in 1972.

Although the Suez Canal reopened in 1974, the maximum oil tanker size exceeded 500,000 DWT in 1976 and the existing largest oil tanker is 565,000 DWT.

Fig. 7-1-3 shows the trend of average oil tanker size based on Lloyd's Statistical Table. And Fig. 7-1-4 shows the trend of average oil tanker size based on Fearnleys Data.

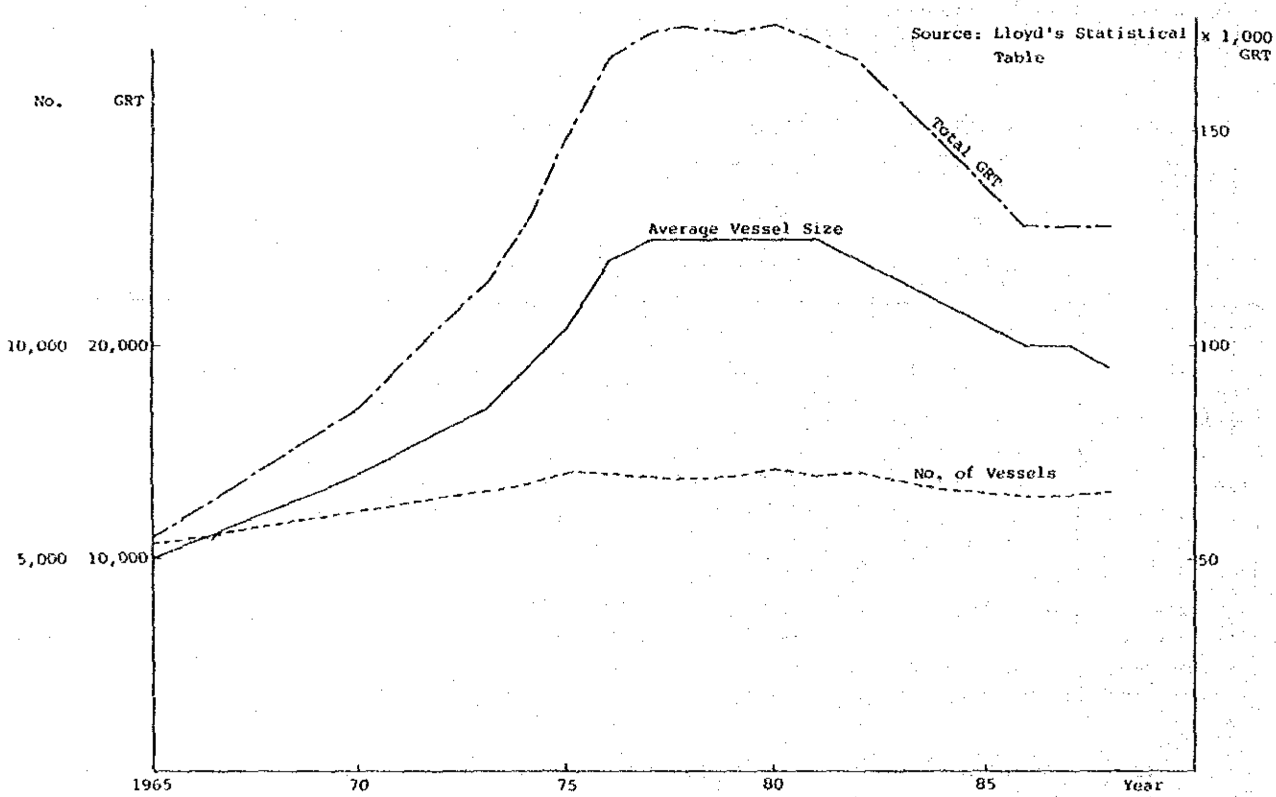


Fig. 7-1-3 Trend of Average Oil Tanker Size

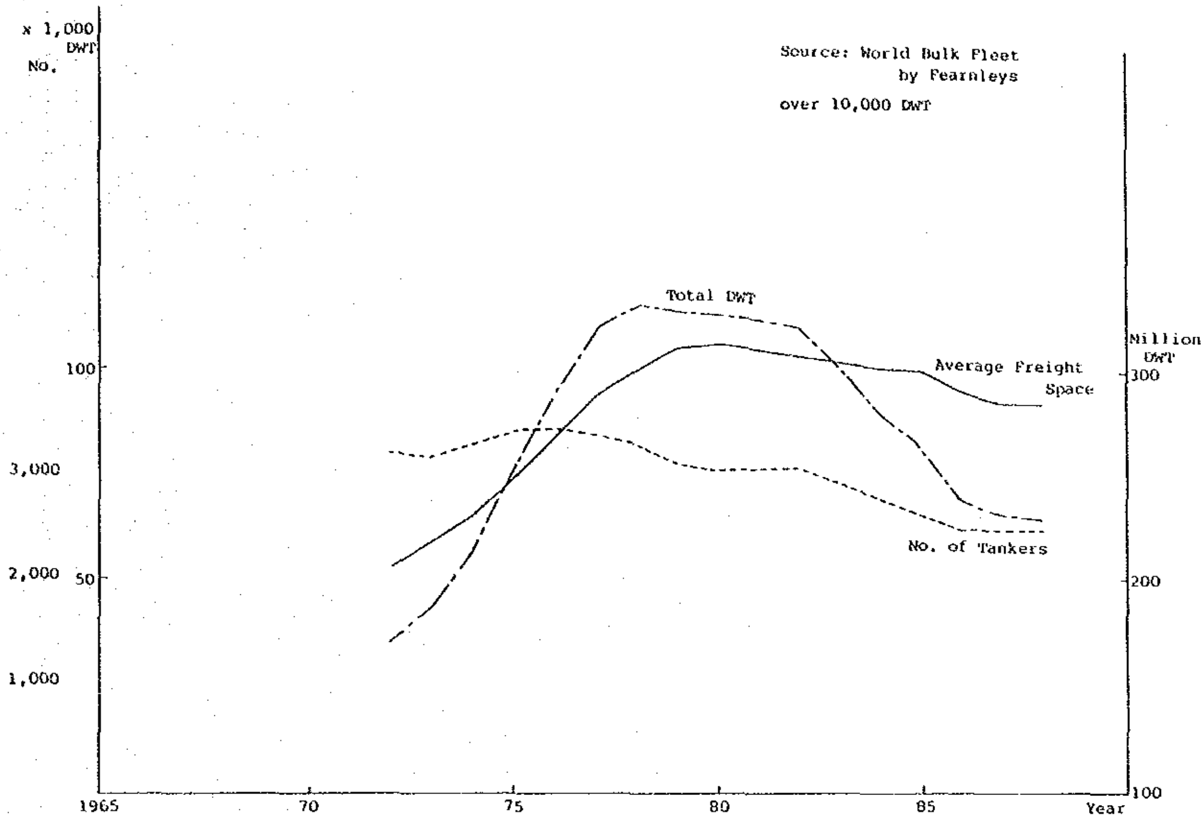


Fig. 7-1-4 Trend of Average Oil Tanker Size

According to Lloyd's Statistical Table, viz Fig. 7-1-3, the number of oil tankers increased up to 1975, but it was almost stable between 1975 and 1982. From 1982, it has been decreasing. According to Fearnleys Data, the number of oil tankers over 10,000 DWT also increased up to 1975 and has been decreasing since then.

According to Lloyd's Statistical Table, the total vessel size (GRT) had been increasing up to 1977, and became stable between 1977 and 1980. Since then it has been decreasing. According to Fearnleys Data, the total oil carrying capacity of oil tankers over 10,000 DWT had been increasing up to 1978, and has been decreasing since then.

The average vessel size of oil tankers over 100 GRT was 10,000 GRT in 1965 and increased up to 25,000 GRT in 1978, and is 19,000 GRT at present. The average vessel size at present is just the same as that in 1974. The average freight space of oil tankers over 10,000 DWT was 53,400 DWT in 1972 and increased up to 106,400 DWT in 1980. At present it is 92,000 DWT, which is the same level as in 1977.

Fig. 7-1-5 shows a comparison of the oil tanker size distribution in 1975 with that in 1988. By comparing oil tanker size distribution in each year, the increased vessel classes are as follows.

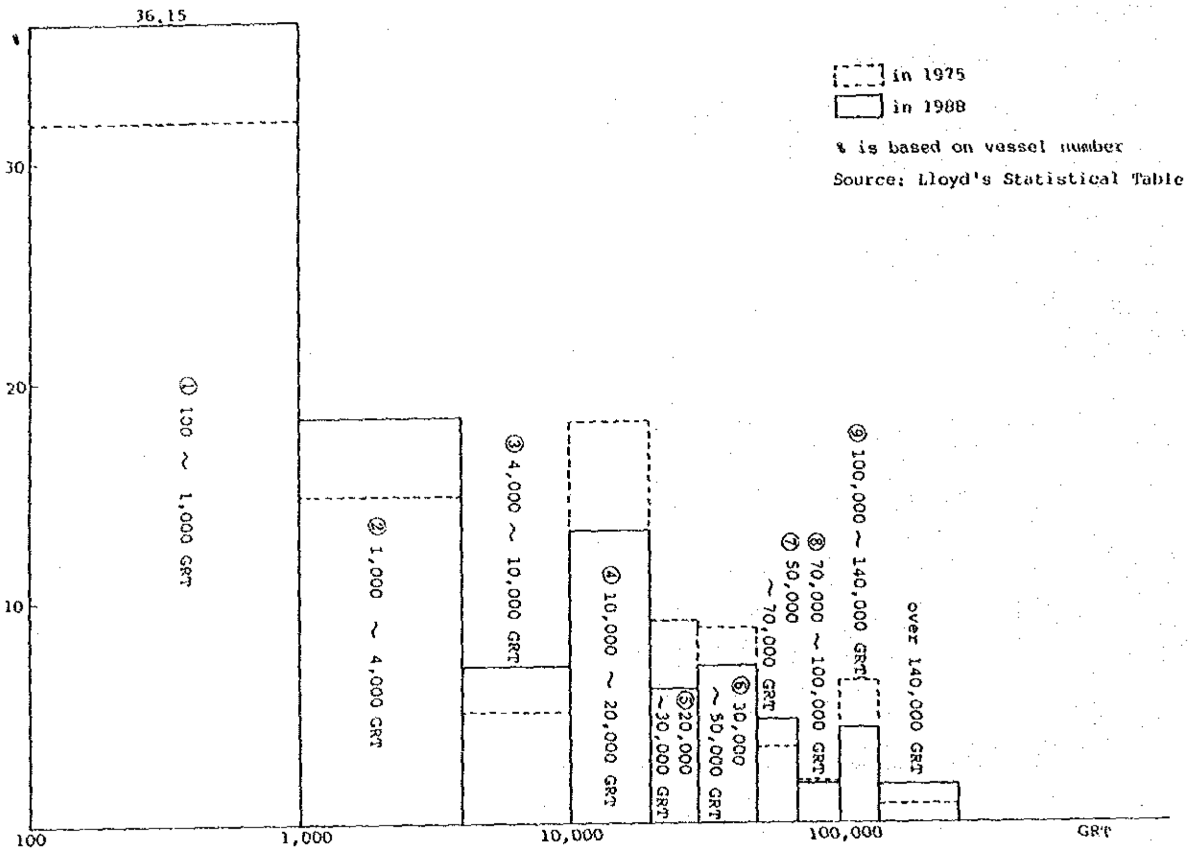


Fig. 7-1-5 Comparison of Oil Tanker Size Distribution

①	100 - 1,000 GRT		
②	1,000 - 4,000 GRT		
③	4,000 - 10,000 GRT		
⑦	50,000 - 70,000 GRT	Suez-max Class	
⑩	over 140,000 GRT	ULCC Class	

On the other hand, the decreased vessel classes are as follows.

④	10,000 - 20,000 GRT	Handy Class	
⑤	20,000 - 30,000 GRT	Small Class	Pana-max Class
⑥	30,000 - 50,000 GRT	Middle Class	
⑧	70,000 - 100,000 GRT	VLCC Class	
⑨	100,000 - 140,000 GRT	VLCC Class	

Fig. 7-1-6 shows the comparison of the oil tanker size distribution in 1981 with that in 1988. The increased classes are as follows.

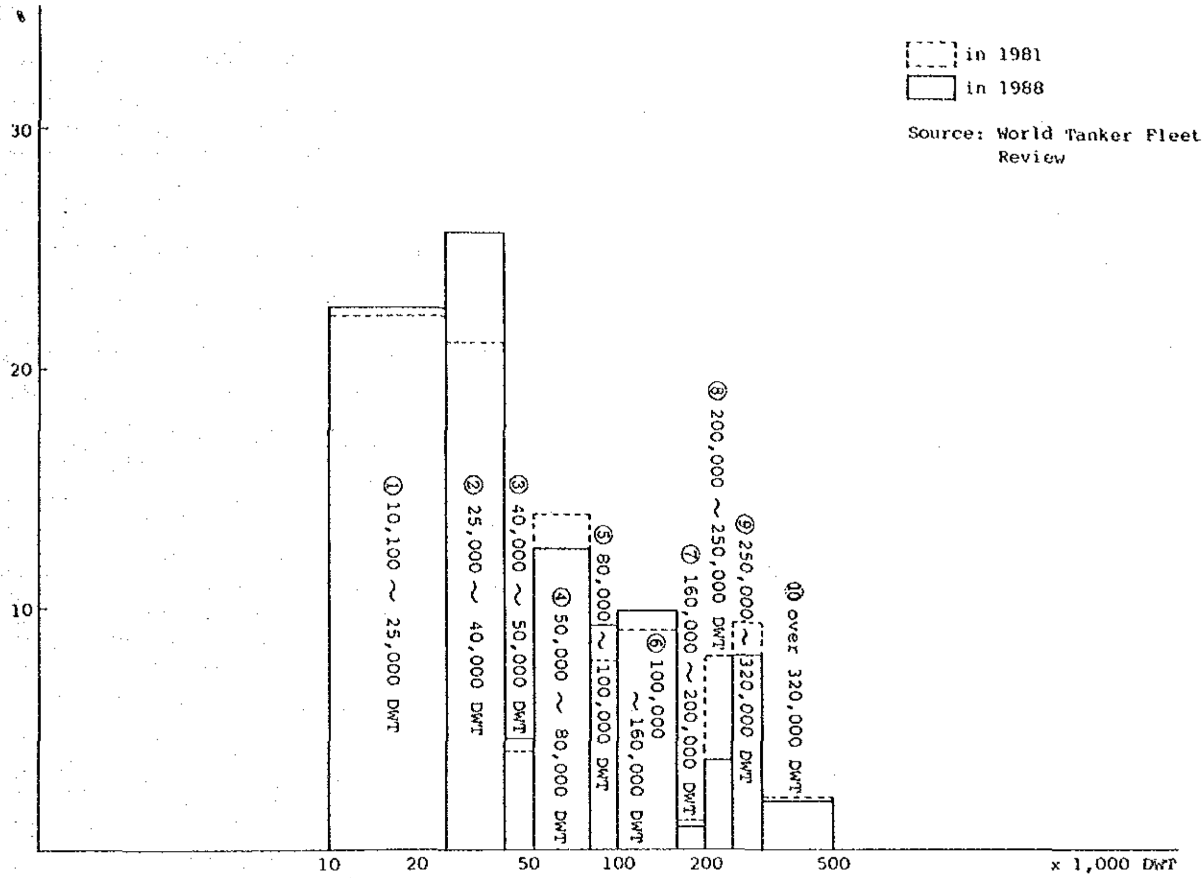


Fig. 7-1-6 Comparison of Oil Tanker Size Distribution

①	10,000 - 25,000 DWT	Handy Class
②	25,000 - 40,000 DWT	Small Class
③	40,000 - 80,000 DWT	Small Class
⑤	80,000 - 100,000 DWT	Middle Class
⑥	100,000 - 160,000 DWT	Suez-max Class

Among the above classes, the classes of which the actual vessel number in 1988 exceeds that in 1981 are as follows.

②	25,000 - 40,000 DWT	Small Class
⑤	80,000 - 100,000 DWT	Middle Class

The decreased classes are as follows.

④	50,000 - 80,000 DWT	Middle Class	Pana-max Class
⑦	160,000 - 200,000 DWT	VLCC Class	
⑧	200,000 - 250,000 DWT	VLCC Class	
⑨	250,000 - 320,000 DWT	VLCC Class	
⑩	over 320,000 DWT	ULCC Class	

Fig. 7-1-7 shows the trend of oil tanker size distribution during this decade. From this figure, it is very clear that the number of VLCC class (200,000 - 250,000 DWT) oil tankers has been decreasing greatly, and the number of the small vessel class (25,000 - 40,000 DWT) and the middle vessel class (80,000 - 100,000 DWT) has increased. At present the largest number of oil tankers over 10,000 DWT is the small vessel class (25,000 - 40,000 DWT) followed by the small vessel class (10,000 - 25,000 DWT). But the largest freight space of oil tankers over 10,000 DWT is the VLCC class (250,000 - 300,000 DWT) followed by the Suez-max class (100,000 - 160,000 DWT).

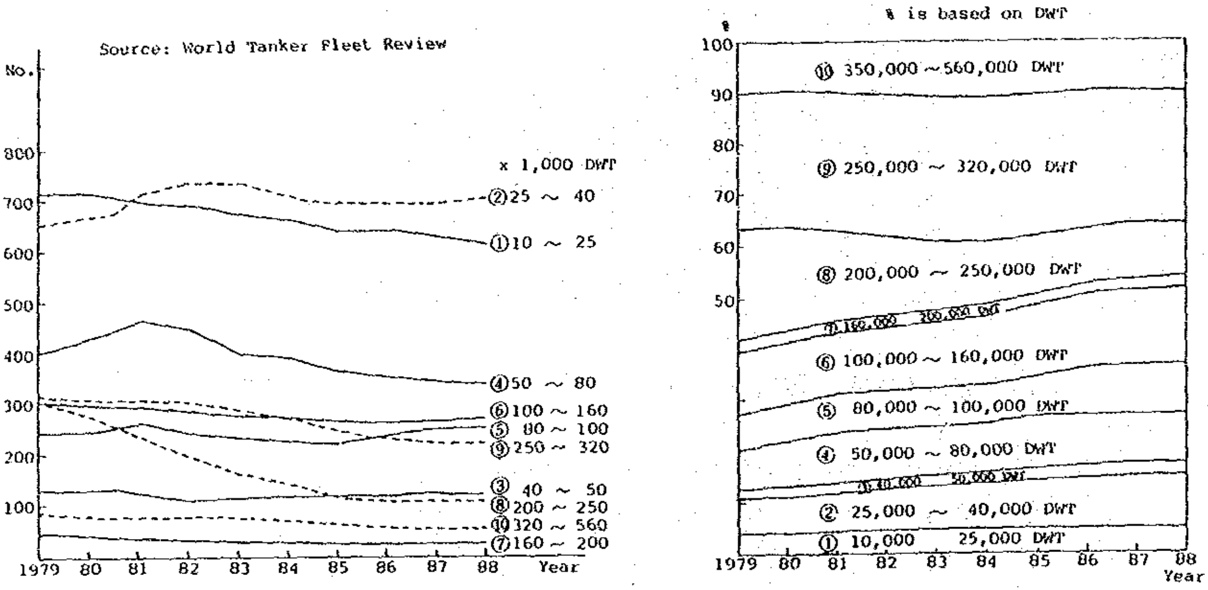


Fig. 7-1-7 Trend of Oil Tanker Size Distribution

The number of so-called VLCC (200,000 - 320,000 DWT) oil tankers decreased greatly during this decade from 617 in 1979 to 325 in 1988. The number of so-called ULCC (over 320,000 DWT) oil tankers also decreased greatly from 82 in 1979 to 56 in 1988.

The number of oil tankers over the so called Suez-max (over 100,000 DWT) also decreased greatly from 1,048 in 1979 to 680 in 1988.

Only the oil tankers in the small vessel class (25,000 - 40,000 DWT) and in the middle vessel class (80,000 - 100,000 DWT) increased from 657 and 244 in 1979 to 704 and 343 in 1988 respectively.

3) Trend of World Seaborne Trade

The following table shows the trend of world seaborne trade by commodity.

Table 7-1-7 World Seaborne Trade

(Unit: Million tons)

Year	Crude Oil	Oil Products	Total Oil	Iron Ore	Coal	Food Grain	Sub Total	Others	Dry Bulk Total	Grand Total	Share of Oil
1965	552	175	727	152	59	82	293	618	911	1,638	44 %
1970	996	245	1,241	247	101	89	437	804	1,241	2,482	50
1975	1,263	233	1,496	292	127	137	556	995	1,551	3,047	49
1976	1,410	260	1,670	294	127	146	567	1,075	1,642	3,312	50
1977	1,451	273	1,724	276	132	147	555	1,120	1,675	3,399	51
1978	1,432	270	1,702	278	127	169	574	1,190	1,764	3,466	49
1979	1,497	279	1,776	327	159	182	668	1,270	1,938	3,714	48
1980	1,320	276	1,596	314	188	198	700	1,310	2,010	3,606	44
1981	1,170	267	1,437	303	210	206	719	1,305	2,024	3,461	41
1982	993	285	1,278	273	208	200	681	1,240	1,921	3,199	40
1983	930	282	1,212	257	197	199	653	1,225	1,878	3,090	39
1984	930	297	1,227	306	232	207	745	1,320	2,065	3,292	37
1985	871	288	1,159	321	272	181	774	1,350	2,135	3,274	35
1986	958	305	1,263	311	276	165	752	1,375	2,122	3,385	37
1987	963	302	1,265	309	272	182	763		2,153	3,418	37

Source: Fearnleys "World Bulk Trades"

Fig. 7-1-8 shows the trend of the world seaborne trade and the world oil trade.

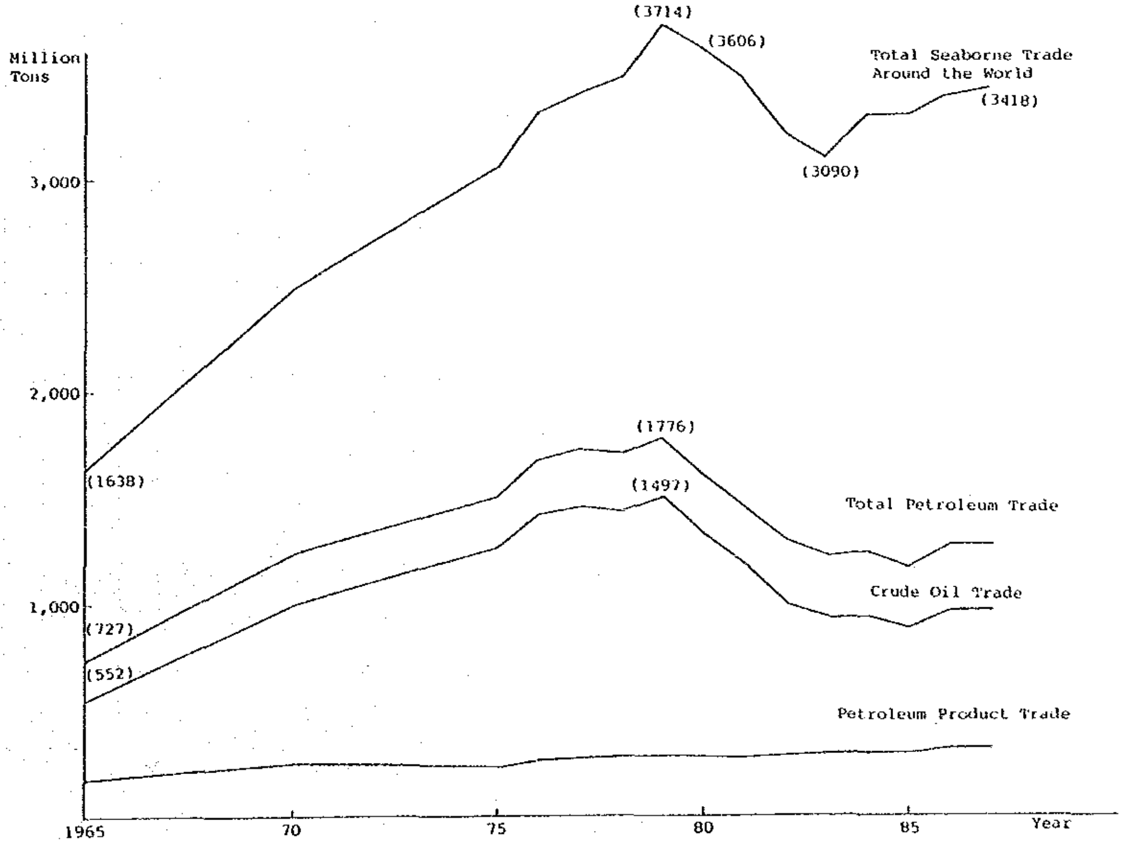


Fig. 7-1-8 Trend of World Seaborne Trade and Oil Trade

The following table shows the trend of world cargo movement by commodity.

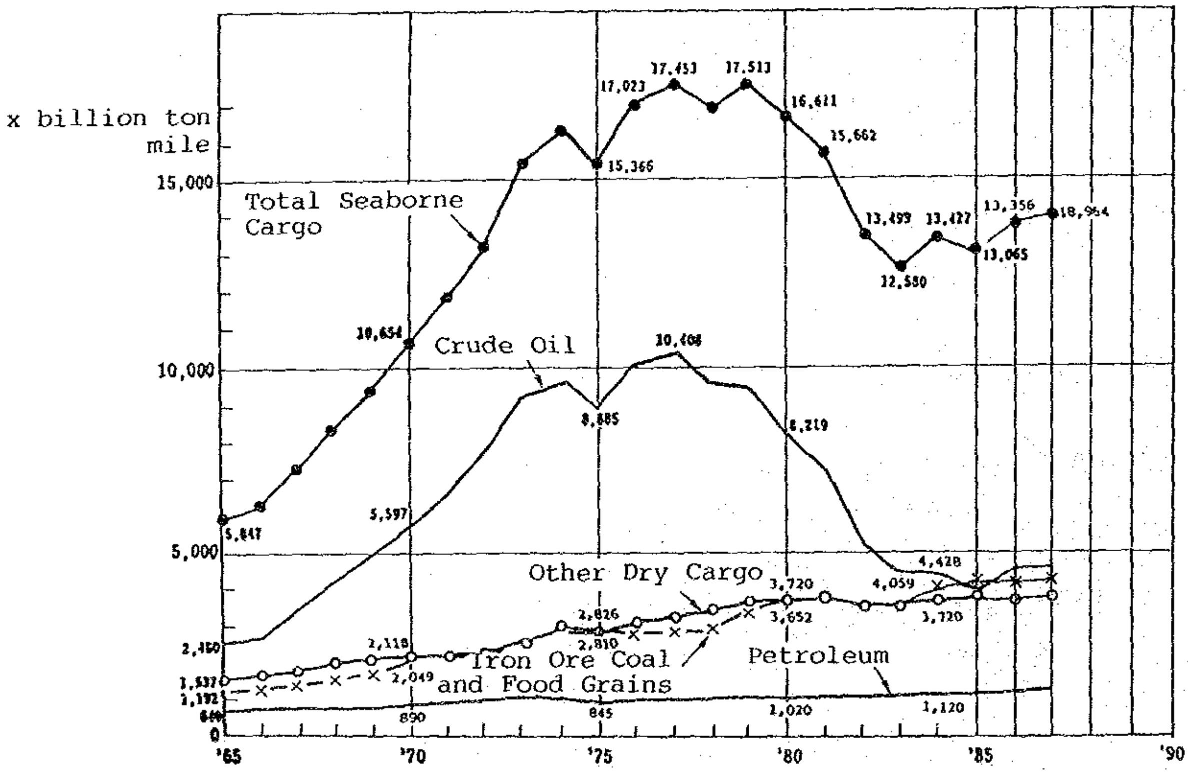
Table 7-1-8 World Cargo Movement

(Unit: billion ton-miles)

	Petroleum			Dry Cargo						Total	Share of
	Crude	Products	Total	Iron Ore	Coal	Food Grains	Sub Total	Others	Total		Petroleum
1962	1,650	650	2,300	314	170	272	756	1,300	2,056	4,356	53 %
1965	2,480	640	3,120	527	216	449	1,192	1,537	2,729	5,849	53
1970	5,598	890	6,296	1,093	481	475	2,049	2,118	4,167	10,463	60
1975	8,885	845	9,730	1,471	621	734	2,826	2,810	5,636	15,366	63
1980	8,219	1,020	9,239	1,613	952	1,087	3,652	3,720	7,372	16,611	56
1983	4,478 (△14.1)	1,080 (0.9)	5,558 (△11.5)	1,320 (△ 8.5)	1,057 (△ 3.4)	1,135 (1.3)	3,512	3,510 (△ 1.4)	7,022 (△ 2.7)	12,580 (△ 6.8)	44
1984	4,508 (0.7)	1,140 (5.6)	5,648 (1.6)	1,631 (23.6)	1,270 (20.2)	1,157 (1.9)	4,058	3,720 (6.0)	7,778 (10.8)	13,426 (6.7)	42
1985	4,007 (△11.1)	1,150 (0.9)	5,157 (△ 8.7)	1,675 (2.7)	1,479 (16.5)	1,004 (△13.2)	4,158	3,750 (0.8)	7,908 (1.7)	13,065 (△ 2.7)	39
1986	4,640 (15.8)	1,265 (10.0)	5,905 (14.5)	1,671 (△ 0.2)	1,586 (7.2)	914 (△ 9.0)	4,171	3,780 (0.8)	7,951 (0.5)	13,856 (6.1)	43
1987	4,610 (△ 0.6)	1,295 (2.4)	5,905 (0.0)	1,650 (△ 1.3)	1,567 (△ 1.2)	1,002 (9.6)	4,219	3,840 (1.6)	6,059 (1.4)	13,964 (0.8)	42

Source: Fearnleys [REVIEW]

Fig. 7-1-9 shows the trend of world cargo movement.



Source: Feanleys "World Bulk Trades", "Review"

Fig. 7-1-9 World Cargo Movement

The total seaborne trade was 3,418 million tons and the total cargo movement was 18,964 billion ton-miles in 1987. The total seaborne trade increased up to 1979, decreased to 1983 and has again increased since then. The trend of the total cargo movement is similar to that of the seaborne trade.

The increase rate of the total seaborne trade was 6.02 % during 1965 to 1979, and 2.55 % during 1983 to 1987.

The total petroleum trade in 1987 was 1,265 million tons of which the crude oil trade was 963 million tons and the petroleum product trade was 302 million tons. The total petroleum movement in 1987 was 5,905 billion ton-miles of which the crude oil movement was 4,610 billion ton-miles and the petroleum product movement was 1,295 billion ton-miles.

The trend of the total petroleum trade is similar to the trend of the total seaborne trade, because the proportion of the total petroleum trade in the total seaborne trade had been about 50 % during 1970-79 and is still 37 % in 1987. The total petroleum trade and the crude oil trade started to decrease in 1980, but the petroleum product trade has steadly increased. The trend of the crude oil movement is similar to the trend of the total cargo movement. The share of total petroleum movement in the total cargo movement was over 50 % during 1962-1980.

4) Forecast of Vessel Size Trend

According to the study of the Japan Marine Research Institute, the excess freight space of oil tankers in 1986 was estimated as 70 million DWT which had decreased from 140 million DWT in 1983. The first oil crisis occurred in 1973 and the second one occurred in 1979. The oil tankers constructed before the second oil crisis were mainly VLCC and the percentage of their tanker freight space remains 40 % of all oil tanker freight space at present. The tankers which were constructed during this period are said to cause the excess freight space of oil tankers. And it is reported that there will still be excess space even by the end of the 1980's, after scrapping some of these tankers.

The Japan Marine Research Institute forecast the future freight space of oil tankers by vessel size by a simulation model which consists of projected scrapping and ordering of oil tankers.

The following table and figure show the results of the simulation.

Table 7-1-9 (a) Forecast of Scrapping Oil Tankers

Unit: Million DWT

Vessel Size \ Year	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	2000
Total	12.7 (24.4)	27.3 (23.3)	24.0 (21.2)	20.1 (18.2)	16.1 (15.0)	14.0 (13.5)	12.9 (12.8)	12.3 (12.5)	11.8 (11.8)	11.2 (11.0)	10.3 (10.0)	9.3 (9.1)	8.5 (8.3)	7.9 (7.8)	7.6 (7.6)
200,000 DWT -	8.5 (14.4)	17.3 (15.0)	16.0 (14.3)	13.6 (12.5)	10.9 (10.3)	9.4 (9.2)	8.4 (8.5)	7.7 (7.9)	6.9 (7.0)	6.1 (6.0)	4.9 (4.8)	3.9 (3.8)	3.0 (3.0)	2.4 (2.4)	2.2 (2.2)
100 - 200,000 DWT	0.9 (4.1)	4.6 (3.8)	3.9 (3.3)	3.2 (2.8)	2.6 (2.3)	2.3 (2.2)	2.2 (2.1)	2.2 (2.2)	2.2 (2.2)	2.3 (2.2)	2.2 (2.1)	2.1 (2.0)	1.9 (1.9)	1.7 (1.7)	1.5 (1.5)
60 - 100,000 DWT	1.1 (2.6)	2.7 (2.2)	2.2 (1.8)	1.7 (1.3)	1.4 (1.3)	1.3 (1.2)	1.3 (1.2)	1.4 (1.4)	1.5 (1.5)	1.6 (1.6)	1.8 (1.8)	1.9 (1.9)	2.0 (2.0)	2.1 (2.1)	2.2 (2.2)
- 60,000 DWT	2.2 (3.2)	2.8 (2.3)	2.0 (1.7)	1.5 (1.3)	1.1 (1.1)	1.0 (1.0)	1.0 (1.0)	1.0 (1.0)	1.1 (1.1)	1.2 (1.2)	1.3 (1.3)	1.4 (1.4)	1.5 (1.5)	1.6 (1.6)	1.7 (1.7)

Note: ( ) Stands for Case II

Table 7-1-9 (b) Forecast of Ordering Oil Tankers

Unit: Million DWT

Vessel Size \ Year	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	2000
Total	5.0 (5.0)	5.0 (5.2)	8.2 (9.3)	13.0 (13.9)	17.5 (18.1)	20.0 (20.1)	22.0 (21.0)	24.2 (20.9)	22.5 (20.8)	20.6 (20.4)	20.2 (20.2)	19.8 (19.8)	19.3 (19.3)	18.8 (18.9)	18.3 (18.4)
200,000 DWT -	2.1 (2.1)	2.3 (2.6)	4.7 (5.4)	8.8 (9.3)	13.6 (13.8)	16.5 (16.2)	17.8 (16.6)	18.0 (15.2)	14.8 (13.5)	11.7 (11.7)	9.9 (10.1)	8.4 (8.8)	7.3 (7.4)	6.5 (7.0)	6.0 (6.4)
100 - 200,000 DWT	0.0 (0.0)	0.0 (0.1)	0.0 (0.3)	0.3 (0.6)	0.7 (1.1)	1.5 (1.8)	2.6 (2.6)	3.8 (3.3)	4.2 (3.8)	4.2 (4.0)	4.3 (4.1)	4.2 (4.0)	4.0 (3.8)	3.8 (3.7)	3.5 (3.4)
60 - 100,000 DWT	1.6 (1.6)	1.5 (1.4)	1.9 (2.1)	2.2 (2.3)	1.9 (1.9)	1.3 (1.3)	1.0 (1.1)	1.4 (1.4)	1.9 (1.9)	2.6 (2.5)	3.3 (3.2)	3.8 (3.7)	4.3 (4.2)	4.6 (4.5)	4.8 (4.6)
- 60,000 DWT	1.2 (1.2)	1.2 (1.1)	1.5 (1.6)	1.7 (1.7)	1.4 (1.3)	0.8 (0.8)	0.6 (0.7)	0.9 (1.1)	1.6 (1.6)	2.2 (2.2)	2.8 (2.8)	3.3 (3.2)	3.7 (3.6)	3.9 (3.8)	4.0 (3.9)

Note: ( ) Stands for Case II

Table 7-1-9 (c) Forecast of Oil Tanker Freight Space

Unit: Million DWT

Vessel Size \ Year	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	2000
Total	239.3 (239.3)	232.9 (221.2)	210.3 (202.5)	191.1 (186.3)	177.3 (175.2)	171.2 (170.7)	170.9 (171.5)	174.0 (175.6)	178.8 (180.4)	185.1 (186.1)	192.2 (192.6)	199.9 (199.9)	208.0 (207.7)	216.3 (215.9)	224.6 (224.1)
200,000 DWT -	121.1 (121.1)	114.3 (108.4)	98.7 (94.9)	84.7 (82.7)	74.4 (73.9)	69.6 (70.2)	70.0 (71.1)	74.2 (75.6)	80.1 (81.3)	87.2 (87.4)	94.3 (93.8)	101.2 (100.2)	107.7 (106.4)	113.8 (112.3)	119.3 (117.7)
100 - 200,000 DWT	40.3 (40.3)	39.9 (36.7)	35.6 (33.2)	31.8 (30.0)	28.6 (27.4)	26.2 (25.5)	24.3 (24.0)	23.0 (23.1)	22.3 (22.7)	22.3 (22.8)	22.8 (23.3)	23.7 (24.1)	24.8 (25.2)	26.1 (26.5)	27.6 (27.9)
60 - 100,000 DWT	39.1 (39.1)	40.2 (38.7)	39.1 (38.1)	38.5 (37.7)	38.4 (38.0)	39.0 (38.7)	39.6 (39.5)	40.0 (39.9)	39.7 (39.8)	39.3 (39.6)	39.0 (39.3)	38.9 (39.2)	39.1 (39.5)	39.5 (39.9)	40.1 (40.5)
- 60,000 DWT	38.8 (38.8)	38.4 (37.4)	36.9 (36.3)	36.2 (35.8)	36.0 (35.8)	36.5 (36.3)	36.9 (36.7)	37.0 (36.8)	36.7 (36.6)	36.3 (36.3)	36.1 (36.2)	36.3 (36.3)	36.3 (36.7)	36.9 (37.2)	37.6 (37.9)

Note: ( ) Stands for Case II

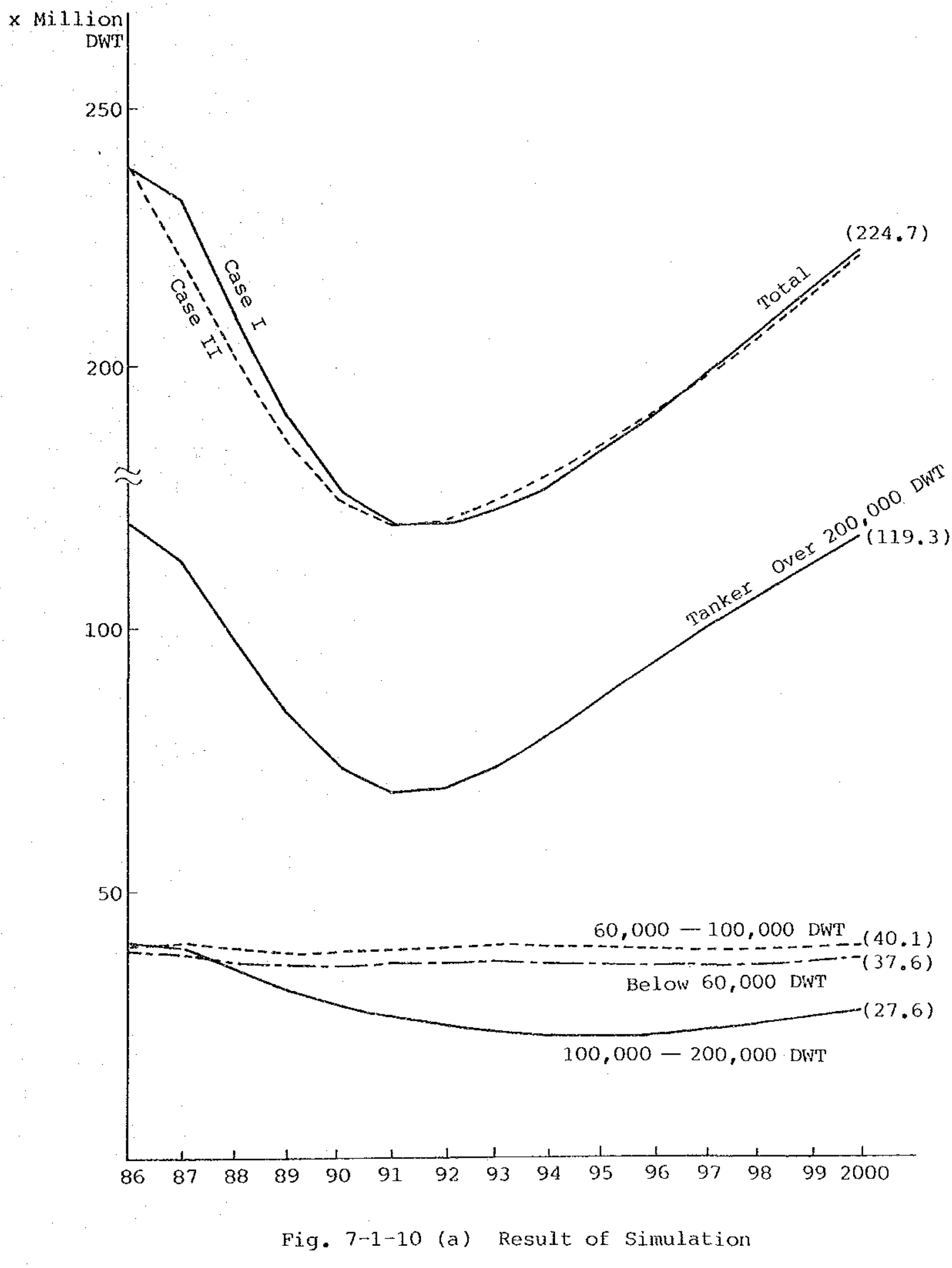


Fig. 7-1-10 (a) Result of Simulation

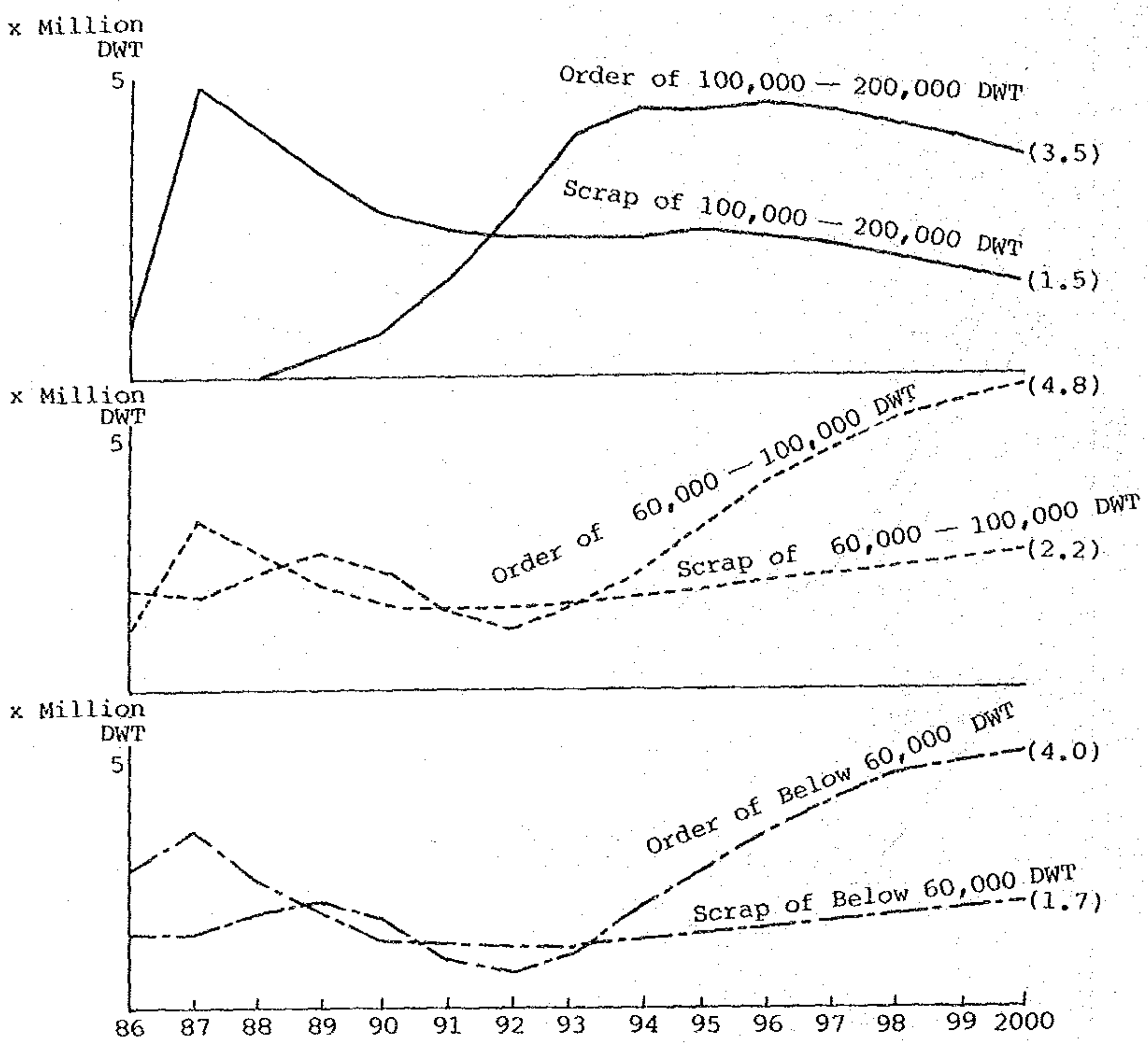


Fig. 7-1-10 (b) Result of Simulation

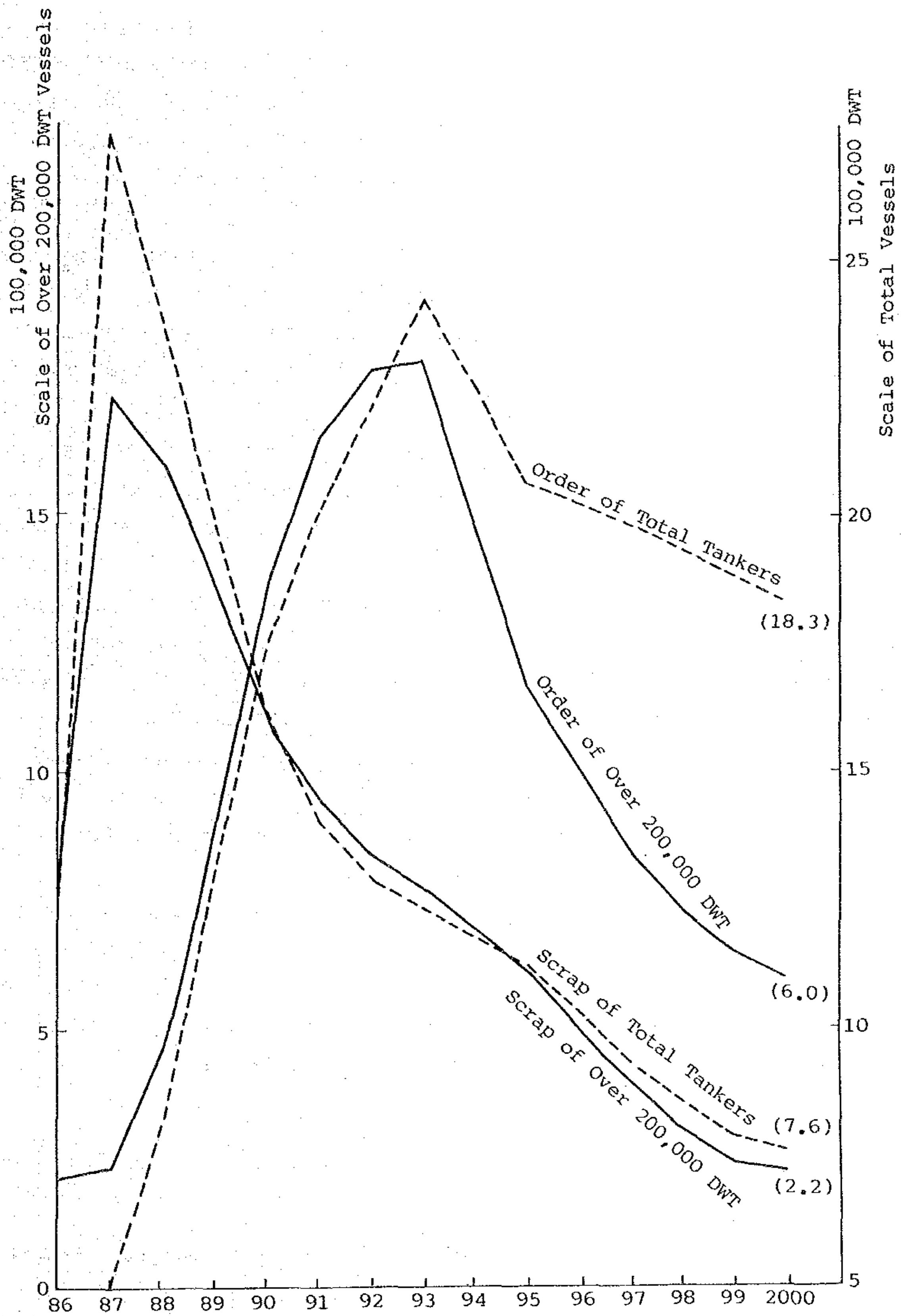


Fig. 7-1-10 (c) Result of Simulation

According to the result of the simulation, the freight space of the oil tankers below 60,000 DWT will be almost constant at around 37 million DWT. In 1995 the freight space will be 36.3 million DWT, and the share of this class of freight space will be 19.6 % of the total freight space. In 2000, the freight space of this class tankers will be 37.6 million DWT, and the share of this class freight space will be 16.7 %.

The report did not classify in more detail, but this class vessel size consists of 10,000 DWT to 60,000 DWT smaller oil tankers. The full load draft of 10,000 DWT oil tankers is about 7.83 m and that of 60,000 DWT is about 12.6 m. So this class tankers presents objective vessel size at Calcutta/Haldia Dock System.

The freight space of oil tankers between 60,000 to 100,000 DWT will also be constant at around 40 million DWT. The freight space of this class of oil tankers will be 39.3 million DWT in 1995 and will be 40.1 million DWT in 2000.

After 1993, the orders for oil tankers between 10,000 DWT and 100,000 DWT will gradually increase and the orders for oil tankers below 60,000 DWT will reach 4.0 million DWT in 2000. The orders for oil tankers between 60,000 DWT and 100,000 DWT will reach 4.8 million DWT in 2000.

The freight space of oil tankers between 100,000 DWT and 200,000 DWT will decrease from 40.3 million DWT to 22.3 million DWT in 1995 and will recover up to 27.6 million DWT in 2000. The orders will exceed the scrapped space in 1992 and will be 4.2 million DWT in 1996.

The freight space of oil tankers over 200,000 DWT will decrease greatly from 121.1 million DWT to 69.6 million DWT in 1991 and will recover up to 87.2 million DWT in 1995 and 119.3 million DWT in 2000. The scrapping of this class oil tankers will proceed greatly by 1990 and new orders will come out at the beginning of the early 1990's.

(2) Dry Bulk Carriers

1) Present Vessel Size Distribution

a) Proportion of Classified Vessel Size

The vessel size distribution of dry bulk carriers and combi-carriers in 1988 is as follows.

Table 7-1-10 Present Vessel Size Distribution

Vessel Size 1,000 DWT		Bulk Carriers				Combi-Carriers				Total			
		No.	%	DWT	%	No.	%	DWT	%	No.	%	DWT	%
				x1,000				x1,000				x1,000	
①	10-18	527	11.3	7,759	4.0	2	0.7	30	0.1	529	10.7	7,789	3.4
②	18-25	801	17.2	17,269	8.9	1	0.3	24	0.1	802	16.2	17,293	7.6
③	25-40	1,853	39.8	58,393	30.2	1	0.3	28	0.1	1,854	37.5	58,421	25.8
	10-40	3,181	68.3	83,421	43.2	4	1.4	82	0.2	3,185	63.8	83,503	36.8
④	40-50	423	9.1	18,362	9.5	17	5.9	808	2.4	440	8.9	19,170	8.5
⑤	50-60	194	4.2	10,512	5.4	17	5.9	943	2.8	211	4.3	11,455	5.0
⑥	60-80	522	11.2	34,629	17.9	54	18.9	4,041	12.0	576	11.7	38,670	17.0
	40-80	1,139	24.5	63,503	32.9	88	30.8	5,792	17.2	1,227	24.8	69,295	30.5
⑦	80-100	45	1.0	3,857	2.0	23	8.0	2,035	6.0	68	1.4	5,892	2.6
⑧	100-150	197	4.2	24,982	12.9	102	35.7	12,182	36.2	299	6.1	37,164	16.4
⑨	150-200	75	1.6	12,944	6.7	43	15.0	6,994	20.8	118	2.4	19,938	8.8
⑩	200-250	13	0.3	2,801	1.4	15	5.2	3,476	10.3	28	0.6	6,277	2.8
⑪	250-300	5	0.1	1,323	0.7	8	2.8	2,190	6.5	13	0.3	3,513	1.5
⑫	300-400	1	0.0	365	0.2	3	1.0	916	2.7	4	0.1	1,281	0.6
	80 -	336	7.2	46,272	24.0	194	67.8	27,793	82.6	530	10.7	74,065	32.6
	Total	4,656	100.0	193,196	100.0	286	100.0	33,667	100.0	4,942	100.0	226,863	100.0

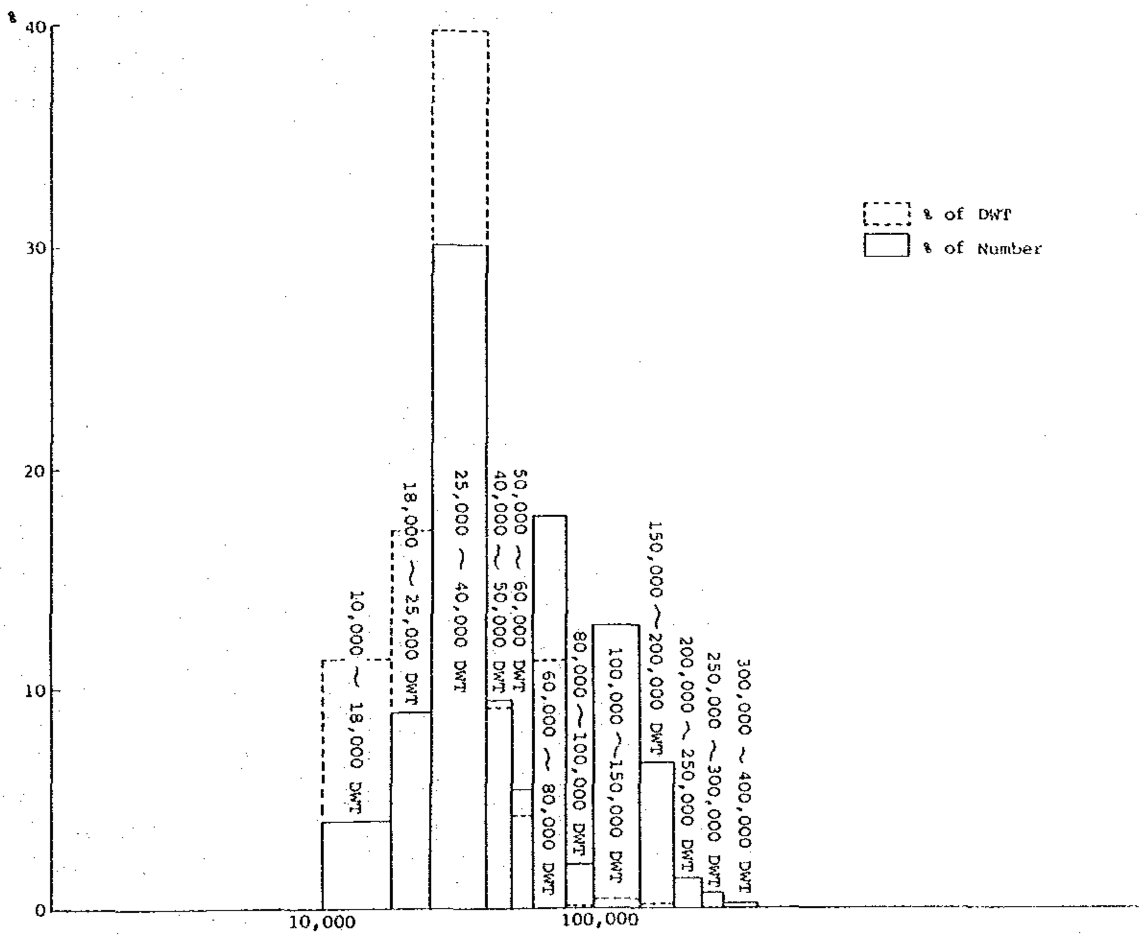


Fig. 7-1-11 Vessel Size Distribution of Dry Bulk Carriers in 1988

As Fig. 7-1-11 shows, the proportion of dry bulk carriers between 25,000 DWT and 40,000 DWT to the total number of dry bulk carriers is over one-third, viz 39.8 %, followed by the dry bulk carriers between 18,000 DWT and 40,000 DWT. The freight space of the dry bulk carriers between 25,000 DWT and 40,000 DWT to the total freight space of dry bulk carriers is 30.2 % followed by the dry bulk carriers between 60,000 DWT and 80,000 DWT.

Fig. 7-1-12 shows the vessel size distribution of combination carriers. The combination carriers consist of the so-called O/O (Ore/Oil), OBO (Ore/Bulk/Oil) and OSO (Ore/Slury/Oil) carriers. The proportion of the combi-carriers between 100,000 DWT and 150,000 DWT to the total number of combi-carriers is over one-third, viz 35.7 % followed by the combi-carriers between 60,000 DWT and 80,000 DWT. The proportion of the freight space between 100,000 DWT and 150,000 DWT is 36.2 % followed by the combi-carriers between 150,000 DWT and 200,000 DWT.

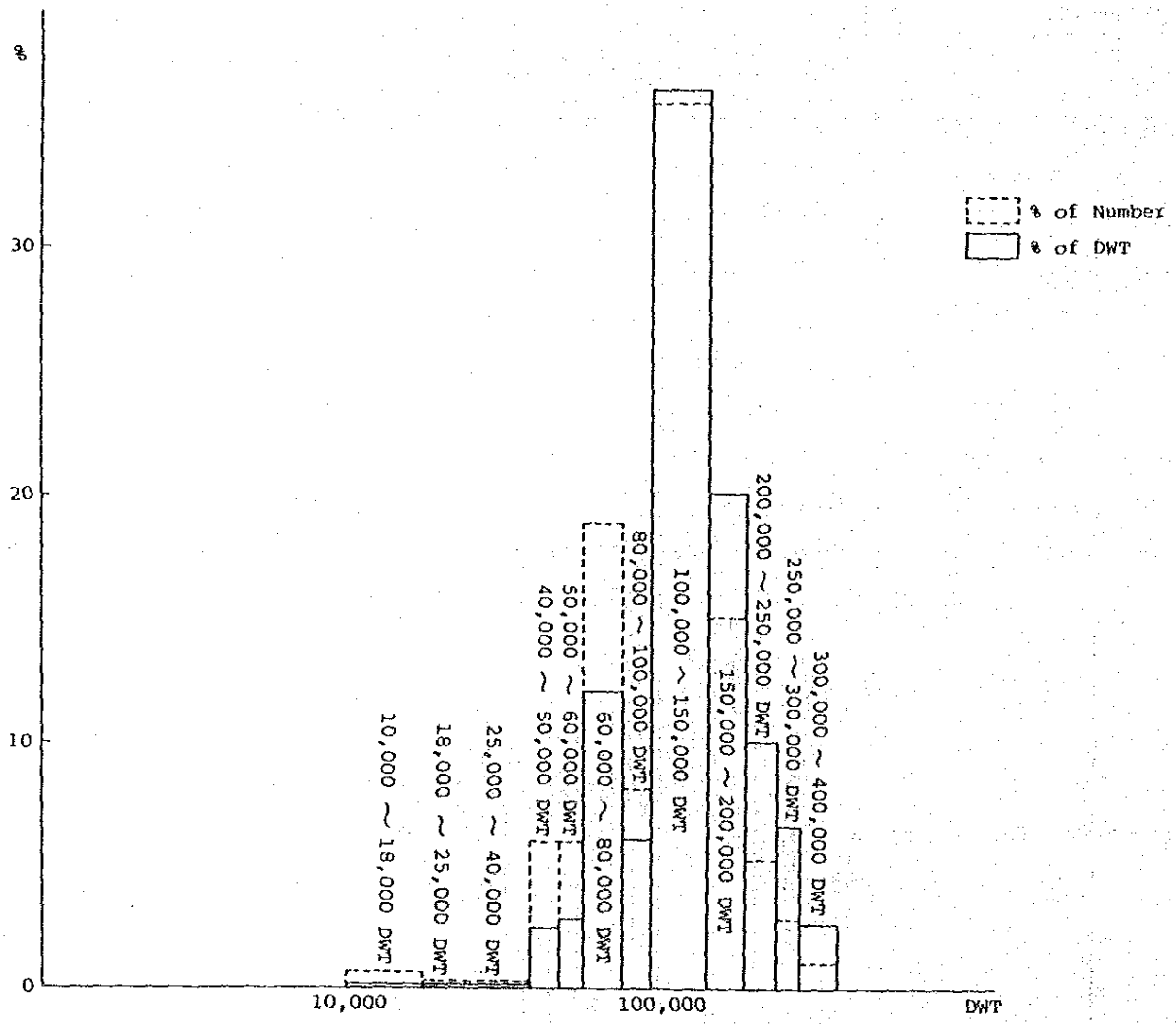


Fig. 7-1-12 Vessel Size Distribution of Combi-Carriers in 1988

b) Dimensions of Vessel Size

From the "PHRI" report the following formulae regarding dry bulk carriers are obtained.

$\log L = 0.768 + 0.331 \log DWT$ (< 5,000 DWT) - ⑦

$\log L = 0.981 + 0.288 \log DWT$ (≥ 5,000 DWT) - ⑧

$\log d = -0.218 + 0.280 \log DWT$ (< 5,000 DWT) - ⑨

$\log d = -0.075 + 0.243 \log DWT$ (≥ 5,000 DWT) - ⑩

$\log B = 0.065 + 0.296 \log DWT$ (< 5,000 DWT) - ⑪

$\log B = -0.144 + 0.347 \log DWT$ (≥ 5,000 DWT) - ⑫

$\log G.T = -0.245 + 1.003 \log DWT$ (< 5,000 DWT) - ⑪'

$\log G.T = 0.289 + 0.885 \log DWT$ (≥ 5,000 DWT) - ⑫'

where L: Length over all of vessels (m)
d: Full loaded draft (m)
B: Breadth of vessels (m)

The standard deviations and the coefficients of correlation of the above respective formulae are as follows.

Table 7-1-11 Standard Deviations and Coefficients of Correlation

No. of formula	a	r
⑦	0.013	0.990
⑧	0.018	0.978
⑨	0.023	0.958
⑩	0.018	0.970
⑪	0.010	0.992
⑫	0.040	0.933
⑪'	0.034	0.993
⑫'	0.066	0.970

The major commodities carried by dry bulk carriers are as follows.

① Iron Ore ② Coal ③ Food Grains ④ Bauxite ⑤ Rock Phosphate

The formulae regarding these cargo carriers are obtained from the "PHRI" report.

(Coal Carriers)

$\log L = 0.7531 + 0.3337 \log DWT$ - ⑬

$\log d = -0.0984 + 0.2487 \log DWT$ - ⑭

$\log B = 0.1066 + 0.2920 \log DWT$ - ⑮

	a	r
⑬	0.064	0.917
⑭	0.015	0.923
⑮	0.021	0.904

(Food Grains Carriers)

$\log L = 0.7823 + 0.3273 \log DWT$ - ⑯

$\log d = -0.1040 + 0.2516 \log DWT$ - ⑰

$\log B = 0.0478 + 0.3046 \log DWT$ - ⑱

	a	r
⑯	0.013	0.974
⑰	0.015	0.950
⑱	0.019	0.943

(Ore Carriers)

$\log L = 1.0096 + 0.2702 \log DWT$ - ⑲

$\log d = -0.2850 + 0.2921 \log DWT$ - ⑳

$\log B = -0.0644 + 0.3209 \log DWT$ - ㉑

	a	r
⑲	0.020	0.977
⑳	0.020	0.978
㉑	0.023	0.970

By using the above formulae, the dimensions of dury bulk carriers can be calculated as follows.

Table 7-1-12 Calculated Dimensions of Dry Bulk Carriers

			Dry Bulk Carriers			Ore Carriers			Coal Carriers			Food Grains Carriers		
	DWT	GRT ⑪	L⑧	d ⑩	B ⑫	L ⑲	d ⑳	B ㉑	L ⑬	d ⑭	B ⑮	L ⑯	d ⑰	B ⑱
			m	m	m	m	m	m	m	m	m	m	m	m
①	10,000	6,745	135.8	7.9	17.5	123.1	7.6	16.6	122.4	7.9	19.0	123.5	8.0	18.5
②	18,000	11,348	160.9	9.1	21.5	144.3	9.1	20.0	149.0	9.1	22.3	149.6	9.3	22.1
③	25,000	15,177	167.4	9.8	24.1	157.7	10.0	22.2	166.2	9.9	24.6	166.6	10.1	24.4
④	40,000	23,005	195.6	11.0	28.4	179.1	11.5	25.8	194.4	11.1	28.2	194.3	11.3	28.2
⑤	50,000	28,028	215.9	11.7	30.7	190.2	12.2	27.8	209.5	11.8	30.1	209.1	12.0	30.1
⑥	60,000	32,935	227.6	12.2	32.7	199.8	12.9	29.4	222.6	12.3	31.8	221.9	12.5	31.9
⑦	80,000	42,485	247.2	13.1	36.1	216.0	14.0	32.3	245.1	13.2	34.5	243.8	13.5	34.8
⑧	100,000	51,761	263.6	13.8	39.0	229.4	15.0	34.7	264.0	14.0	36.9	262.3	14.3	37.2
⑨	150,000	74,104	296.3	15.2	44.9	256.0	16.9	39.5	302.2	15.4	41.5	299.5	15.8	42.1
⑩	200,000	95,590	321.9	16.3	49.6	277.0	18.3	43.3	332.7	16.6	45.1	329.1	17.0	46.0
⑪	250,000	116,460	343.2	17.2	53.6	293.8	19.6	46.5	358.4	17.5	48.2	354.0	18.0	49.2
⑫	300,000	136,852	361.8	18.0	57.1	308.7	20.6	49.3	380.9	18.4	50.8	375.8	18.8	52.0
⑬	400,000	176,532	419.1	19.3	63.1	334.1	22.5	54.1	419.3	19.7	55.3	412.9	20.2	56.8

The following table shows the dimensions of very large dry bulk carriers and combi-carriers in Japan.

Table 7-1-13 Very Large Combi-Carriers & Ore Carriers in Japan

	Name	Owner's Name	GRT	DWT	La(m)	B(m)	D(m)	d(m)	Velocity (knot)	Engine (PS)	Comp. Year	Crew
Combi-carriers	Saiko Maru	Sanko Kisen	128,413	247,924	326.00	52.00	27.30	20.48	16.0	D 36,000	79.03	-
	Sensho Maru	Showa Kaiun	99,388	190,903	299.90	47.00	26.00	19.31	13.0	D 19,300	76.08	31
	Oodel Maru	Sanko Kisen	89,856	172,279	300.00	48.00	23.00	17.71	15.7	D 30,700	79.09	-
	Rapurata Maru	"	92,185	169,584	294.85	47.40	24.10	17.91	15.3	D 29,600	77.06	-
	Kibo Maru	Meiko Enterprise	91,142	169,472	294.85	47.40	24.10	17.92	15.3	D 29,000	76.9	-
Ore Carriers	Usa Maru	Shoyo Kisen	143,304	269,500	337.00	54.50	28.00	21.00	11.0	D 18,000	72.10	27
	Port Head Land Maru	Katori Shosen	123,958	251,191	325.00	52.00	26.50	19.84	13.7	D 20,780	86.11	-
	Kuni Saki Maru	Frend ship	110,039	227,960	325.00	52.00	23.45	18.13	14.0	D 23,000	88.3	-
	Kazusa Maru	NS, Nitetsu Nippo	112,895	227,183	325.01	52.00	24.30	18.13	14.0	D 23,100	88.1	-
	Atta Maru	Shoyo Kaiun	116,648	217,453	327.80	50.00	25.50	19.16	11.6	D 15,000	73.05	28

in 1988

The dimensions of dry bulk carriers below 10,000 DWT can be calculated as follows.

Table 7-1-14 Calculated Dimensions below 10,000 DWT

	GRT	Dry Bulk Carriers				Ore Carriers		
		DWT	L	d	B	L	d	B
			(m)	(m)	(m)	(m)	(m)	(m)
①	100	173	32.3	2.6	4.3	41.1	2.3	4.5
②	1,000	1,719	69.0	4.9	10.5	76.5	4.6	9.4
③	4,000	5,541	114.6	6.8	14.3	105.0	6.4	13.7
④	10,000	15,603	154.4	8.7	20.5	138.9	8.7	19.1

2) Trend of Dry Bulk Carrier Size

Fig. 7-1-13 shows the trend of dry bulk carrier size based on Lloyds Statistical Tables.

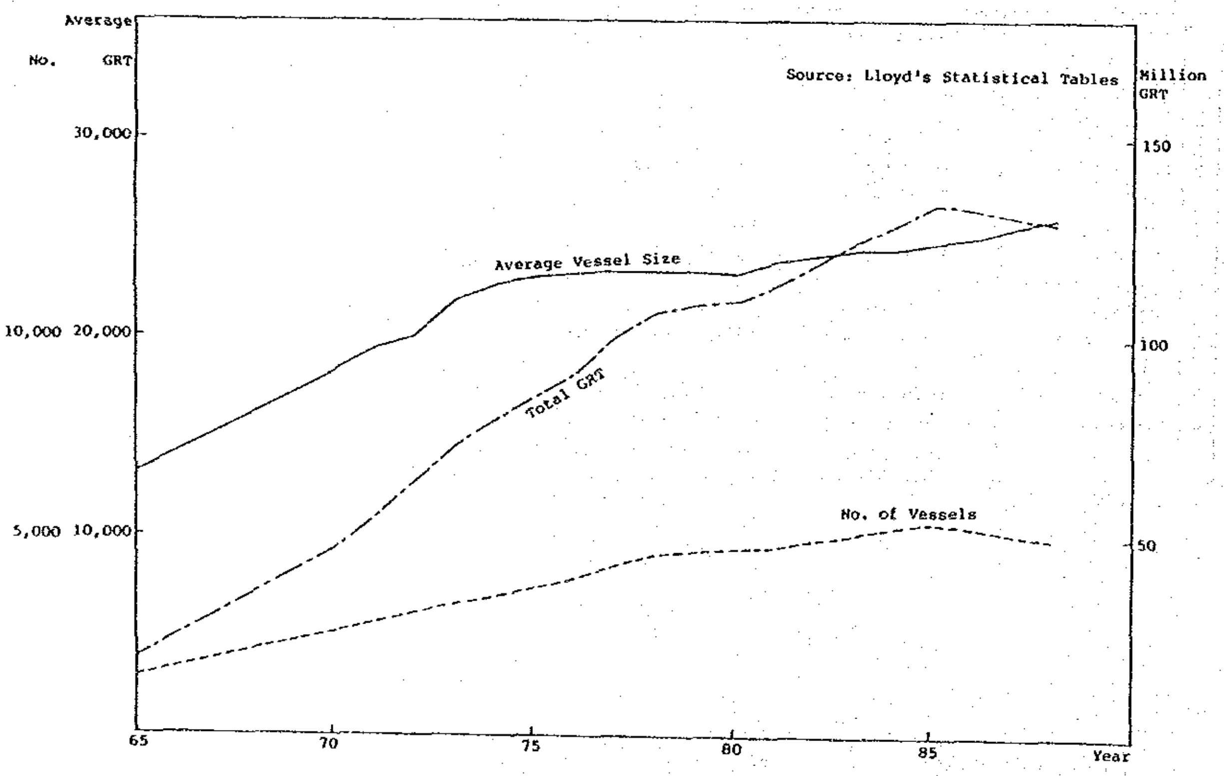


Fig. 7-1-13 (a) Trend of Average Dry Bulk Carrier Size

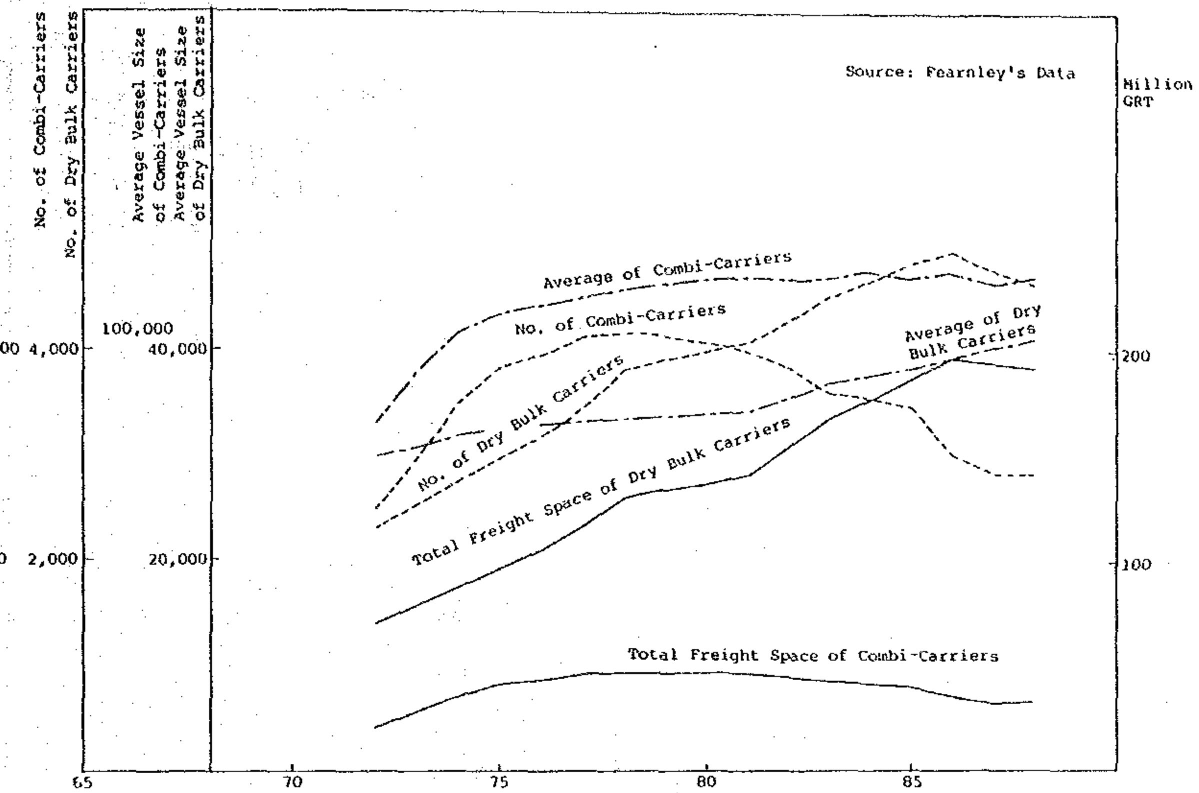


Fig. 7-1-13 (b) Trend of Average Dry Bulk Carrier Size

The number of dry bulk carriers over 100 GRT had increased gradually from 1,403 in 1965 to 5,391 in 1985 and decreased slightly to 4,980 in 1988. The total freight space by GRT had a similar trend to that of the number of dry bulk carriers. The total freight space in 1965 was 18.7 million GRT and it reached 134.0 million GRT in 1985. At present it is 129.6 million GRT. So, the average vessel size has been gradually increasing as follows.

Table 7-1-15 Average Vessel Size and Increase Rate

	1965	1970	1975	1980	1985	1988
Average	GRT 13,369	18,454	23,053	23,289	24,853	26,031
Increasing Rate		6.7%	4.6%	0.2%	1.3%	1.6%

Fig. 7-1-14 shows the trend of dry bulk carrier size based on Fearnley's Data.

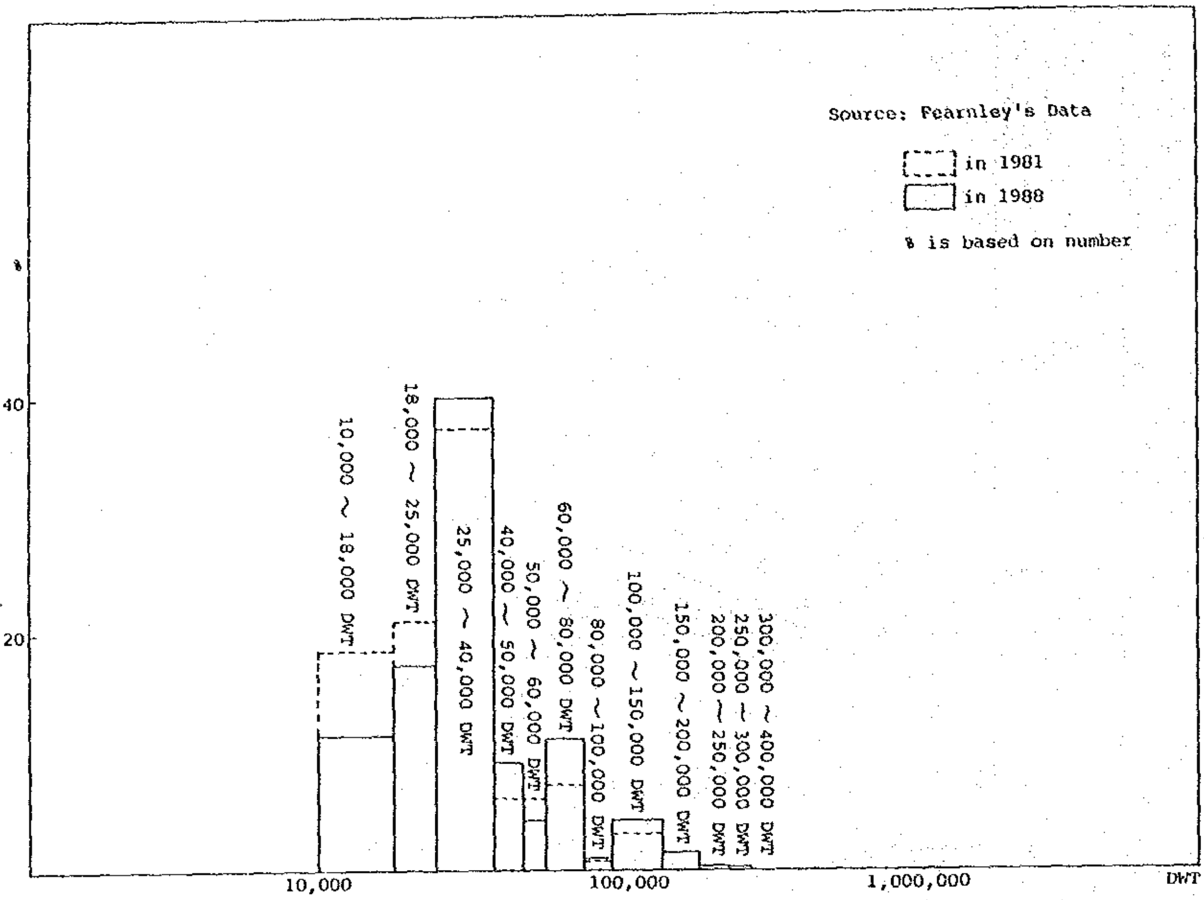


Fig. 7-1-14 (a) Comparison of Dry Bulk Carrier Size Distribution

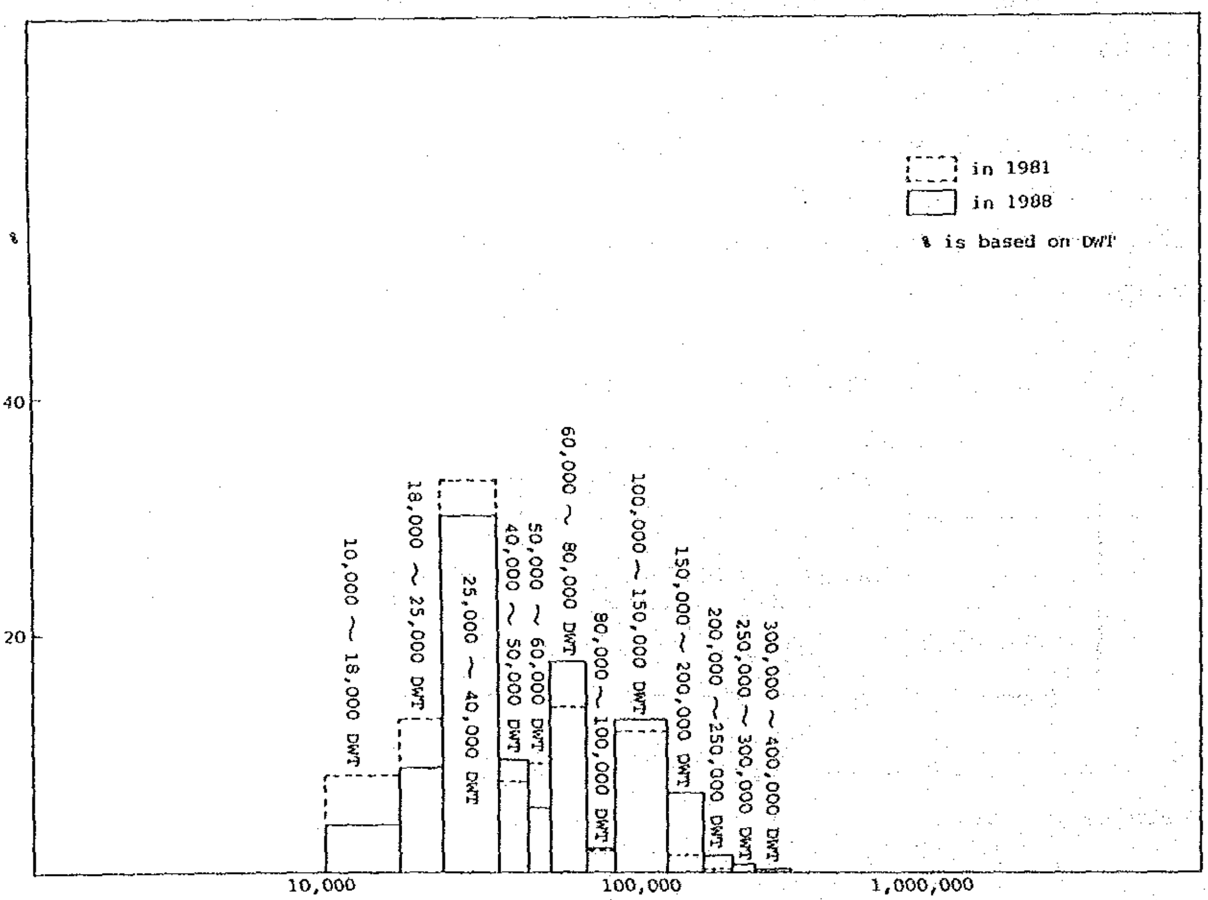


Fig. 7-1-14 (a') Comparison of Dry Bulk Carrier Size Distribution

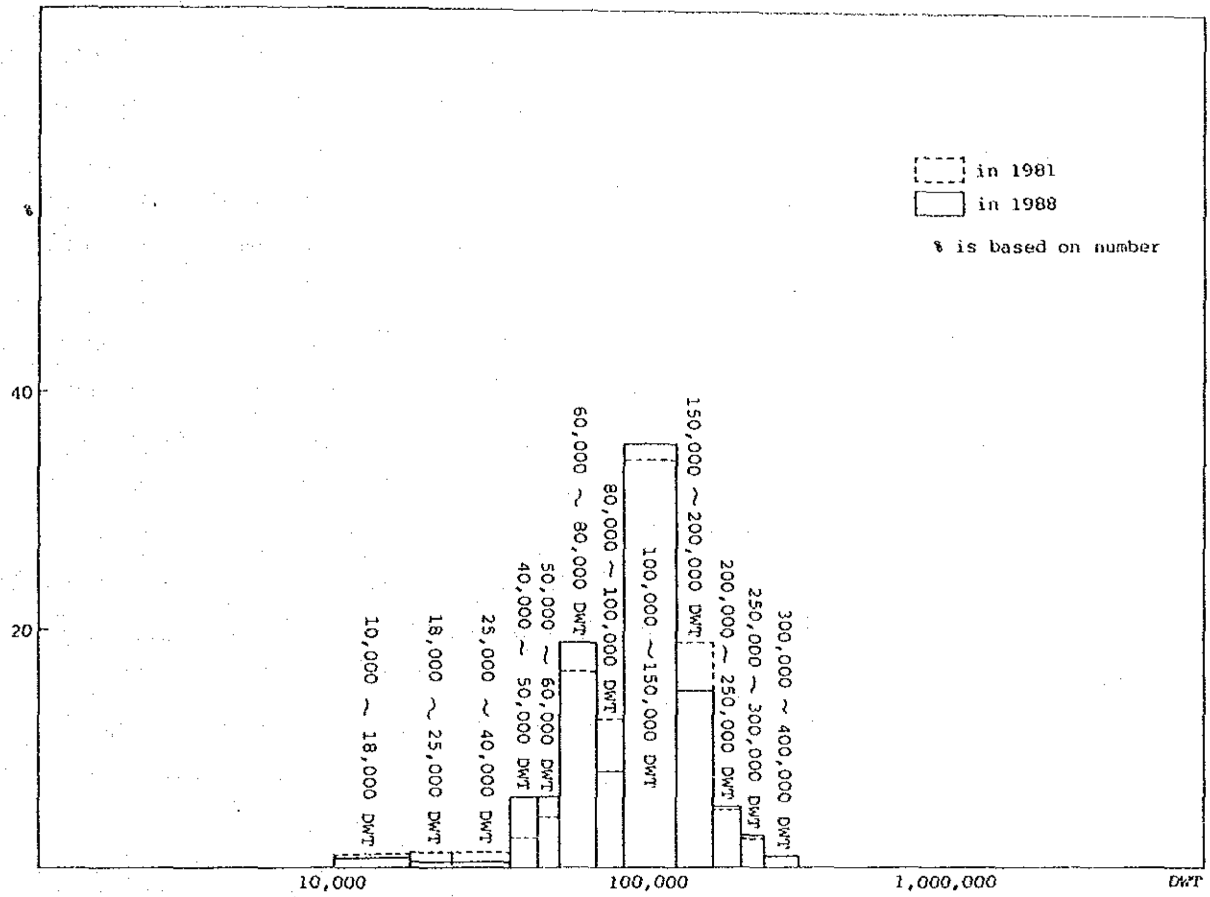


Fig. 7-1-14 (b) Comparison of Combi-Carrier Size Distribution

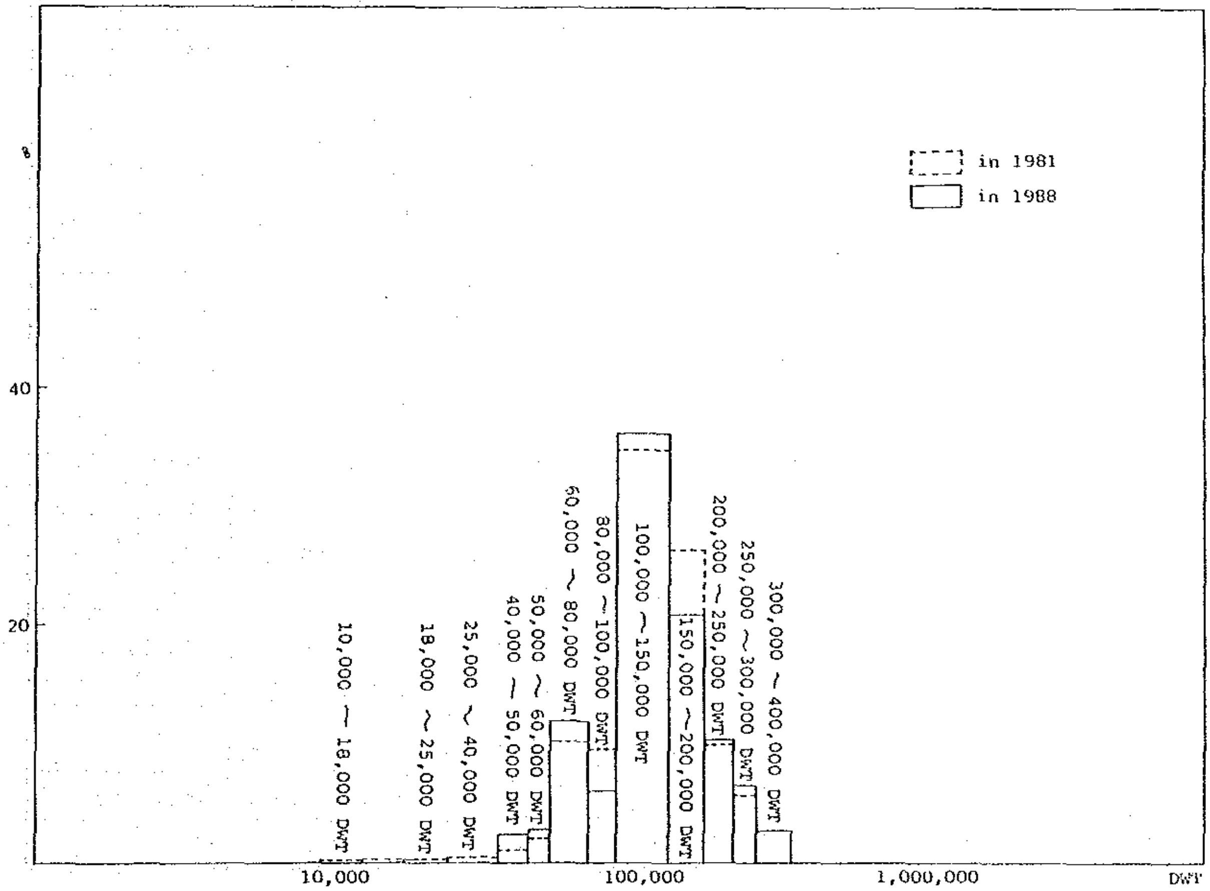


Fig. 7-1-14 (b') Comparison of Dry Bulk Carrier Size Distribution

The total freight space of dry bulk carriers had increased from 70.4 million DWT in 1972 to 197.5 million DWT in 1986 and since decreased to 193.2 million DWT in 1988.

The total freight space of combi-carriers had increased from 21.1 million DWT in 1972 to 48.7 million DWT in 1979 and since gradually decreased to 33.7 million DWT in 1988.

The trend of the number of dry bulk carriers is similar to the trend of the total freight space of dry bulk carriers. The number of combi-carriers had increased from 251 in 1972 to 419 in 1987, but since decreased to 286 in 1988.

The average vessel size of dry bulk carriers has been increasing since 1972 and is now 41,440 DWT. The average vessel size of combi-carriers increased from 84,000 DWT in 1972 to 119,000 DWT in 1983 but has been stable since then.

The following table shows the comparison of vessel size distribution.

Table 7-1-16 (a) Comparison of Dry Bulk Carrier Size Distribution

Vessel Size 1,000 DWT		1988					1981				
		No.	%	DWT x1,000	%	Av x1,000	No.	%	DWT x1,000	%	Av x1,000
①	10-18	527	11.3	7,759	4.0	14.7	760	18.5	11,564	8.1	15.2
②	18-25	801	17.2	17,269	8.9	21.6	863	21.0	18,408	13.0	21.3
③	25-40	1,853	39.8	58,393	30.2	31.5	1,531	37.2	47,155	33.2	30.8
	10-40	3,181	68.3	83,421	43.2	26.2	3,154	76.6	77,127	54.3	24.5
④	40-50	423	9.1	18,362	9.5	43.4	248	6.0	10,898	7.7	43.9
⑤	50-60	194	4.2	10,512	5.4	54.2	243	5.9	13,217	9.3	54.4
⑥	60-80	522	11.2	34,629	17.9	66.3	295	7.2	19,941	14.0	67.6
	40-80	1,139	24.5	63,503	32.9	55.8	786	19.1	44,056	31.0	56.1
⑦	80-100	45	1.0	3,857	2.0	85.7	33	0.8	2,784	2.0	84.4
⑧	100-150	197	4.2	24,982	12.9	126.8	128	3.1	15,500	10.9	121.1
⑨	150-200	75	1.6	12,944	6.7	172.6	13	0.3	2,135	1.5	164.2
⑩	200-250	13	0.3	2,801	1.4	215.5	2	0.0	456	0.3	228.0
⑪	250-300	5	0.1	1,323	0.7	264.6	-	-	-	-	
⑫	300-400	1	0.0	365	0.2	365.0	-	-	-	-	
	80 - 400	336	7.2	46,272	24.0	137.7	176	4.3	20,875	14.7	118.6
Total		4,656	100.0	193,196	100.0	41.5	4,116	100.0	142,058	100.0	34.5

Table 7-1-16 (b) Comparison of Combi-Carrier Size Distribution

Vessel Size 1,000 DWT		1988 No.	1988 %	1988 DWT x1,000	1988 %	1988 Av x1,000	1981 No.	1981 %	1981 DWT x1,000	1981 %	1981 Av x1,000
①	10-18	2	0.7	30	0.1	15	4	1.0	60	0.1	15
②	18-25	1	0.3	24	0.1	24	5	1.2	114	0.2	22.8
③	25-40	1	0.3	28	0.1	28	5	1.2	157	0.3	31.4
	10-40	4	1.4	82	0.2	20.5	14	3.5	331	0.7	23.6
④	40-50	17	5.9	808	2.4	47.5	10	2.5	481	1.0	48.1
⑤	50-60	17	5.9	943	2.8	55.5	17	4.2	963	2.0	56.6
⑥	60-80	54	18.9	4,041	12.0	74.8	66	16.5	4,796	10.1	72.7
	40-80	88	30.8	5,792	17.2	65.8	93	23.2	6,240	13.2	67.1
⑦	80-100	23	8.0	2,035	6.0	88.5	50	12.5	4,476	9.5	89.5
⑧	100-150	102	35.7	12,182	36.2	119.4	138	34.4	16,461	34.8	119.3
⑨	150-200	43	15.0	6,994	20.8	162.7	76	19.0	12,445	26.3	163.8
⑩	200-250	15	5.2	3,476	10.3	231.7	20	5.0	4,594	9.7	229.7
⑪	250-300	8	2.8	2,190	6.5	273.8	10	2.5	2,719	5.7	271.9
⑫	300-400	3	1.0	916	2.7	305.3	-	-	-	-	-
	80 - 400	194	67.8	27,793	82.6	143.3	298	74.3	40,695	86.1	136.6
Total		286	100.0	33,667	100.0	117.7	401	100.0	47,266	100.0	117.9

From Fig. 7-1-14 (a), the decreased classes of dry bulk carriers during 1981 and 1988 are as follows.

① 10,000 - 18,000 DWT ② 18,000 - 25,000 DWT
⑤ 50,000 - 60,000 DWT

The proportion of other classes increased during this period. And the larger dry bulk carriers over 250,000 DWT first appeared during this period. The largest class is 25,000 DWT to 40,000 DWT and the proportion of this class to the total number of dry bulk carriers increased from 37.2 % to 39.8 %. The order of the classes in accordance with the increased number of dry bulk carriers is as follows.

1: ③ 25,000 - 40,000 DWT 322 vessels
2: ⑥ 60,000 - 80,000 DWT 227 vessels
3: ④ 40,000 - 50,000 DWT 175 vessels
4: ⑧ 100,000 - 150,000 DWT 69 vessels
5: ⑨ 150,000 - 200,000 DWT 52 vessels
6: ⑦ 80,000 - 100,000 DWT 12 vessels
7: ⑩ 200,000 - 250,000 DWT 11 vessels
8: ⑪ 250,000 - 300,000 DWT 5 vessels
9: ⑫ 300,000 - 400,000 DWT 1 vessels

From Fig. 7-1-14 (a'), the decreased classes of the freight space of dry bulk carriers are as follows.

① 10,000 - 18,000 DWT ② 18,000 - 25,000 DWT
③ 25,000 - 40,000 DWT ⑤ 50,000 - 60,000 DWT

As the total freight space of dry bulk carriers increased from 142,058,000 DWT in 1981 to 193,196,000 DWT in 1988, so the freight spaces of the class of 25,000 to 40,000 DWT increased from 47,155,000 DWT in 1981 to 58,393,000 DWT in 1988.

As for the increased freight space of each class, the order is as follows.

1: ⑥ 60,000 - 80,000 DWT 14,688 vessels
2: ③ 25,000 - 40,000 DWT 11,238 vessels
3: ⑨ 150,000 - 200,000 DWT 10,809 vessels
4: ⑧ 100,000 - 150,000 DWT 9,482 vessels
5: ④ 40,000 - 50,000 DWT 7,764 vessels
6: ⑩ 200,000 - 250,000 DWT 2,345 vessels
7: ⑪ 250,000 - 300,000 DWT 1,323 vessels
8: ⑦ 80,000 - 100,000 DWT 1,073 vessels
9: ⑫ 300,000 - 400,000 DWT 365 vessels

From Fig. 7-1-14 (b), the proportion of the combi-carriers between 100,000 DWT and 150,000 DWT is over one-third of the total number of combi-carriers. The total number of combi-carriers decreased from 401 in 1981 to 286 in 1988. The increased classes by percentage are as follows.

④ 40,000 - 50,000 DWT ⑤ 50,000 - 60,000 DWT
⑦ 60,000 - 80,000 DWT ⑨ 100,000 - 150,000 DWT
⑩ 200,000 - 250,000 DWT ⑪ 250,000 - 300,000 DWT
⑫ 300,000 - 400,000 DWT

But the actually increased classes are as follows.

④ 40,000 - 50,000 DWT ⑫ 300,000 - 400,000 DWT

As for the decreased number, the order of each class is as follows.

			Decreased No.
1:	⑧	100,000 - 150,000 DWT	36
2:	⑨	150,000 - 200,000 DWT	33
3:	⑦	80,000 - 100,000 DWT	27
4:	⑥	60,000 - 80,000 DWT	12
5:	⑩	200,000 - 250,000 DWT	5
6:	②	18,000 - 25,000 DWT	4
7:	③	25,000 - 40,000 DWT	4
8:	①	10,000 - 18,000 DWT	2
9:	⑪	250,000 - 300,000 DWT	2
10:	⑤	50,000 - 60,000 DWT	0

From Fig. 7-1-14 (b'), there are many classes of which the percentage increased during 1981 to 1988, but the actually increased classes are as follows.

④ 40,000 - 50,000 DWT ⑫ 300,000 - 400,000 DWT

As for the decreased freight space, the order of each class is as follows.

			Decreased FS
1:	⑨	150,000 - 200,000 DWT	5,451,000 DWT
2:	⑧	100,000 - 150,000 DWT	4,279,000 DWT
3:	⑦	80,000 - 100,000 DWT	2,441,000 DWT
4:	⑩	200,000 - 250,000 DWT	1,118,000 DWT

5:	⑥	60,000 - 80,000 DWT	755,000 DWT
6:	⑪	250,000 - 300,000 DWT	529,000 DWT
7:	③	25,000 - 40,000 DWT	129,000 DWT
8:	②	18,000 - 25,000 DWT	90,000 DWT
9:	①	10,000 - 18,000 DWT	30,000 DWT
10:	⑤	50,000 - 60,000 DWT	20,000 DWT

Fig. 7-1-15 shows the trend of the proportion of the freight space of respective vessel classes. The appearance of huge bulk carriers during the 1970's causes the decrease of the proportion of bulk carriers below 100,000 GRT (180,000 DWT). During 1970 to 1975, the expanded vessel size was 50,000 to 100,000 GRT.

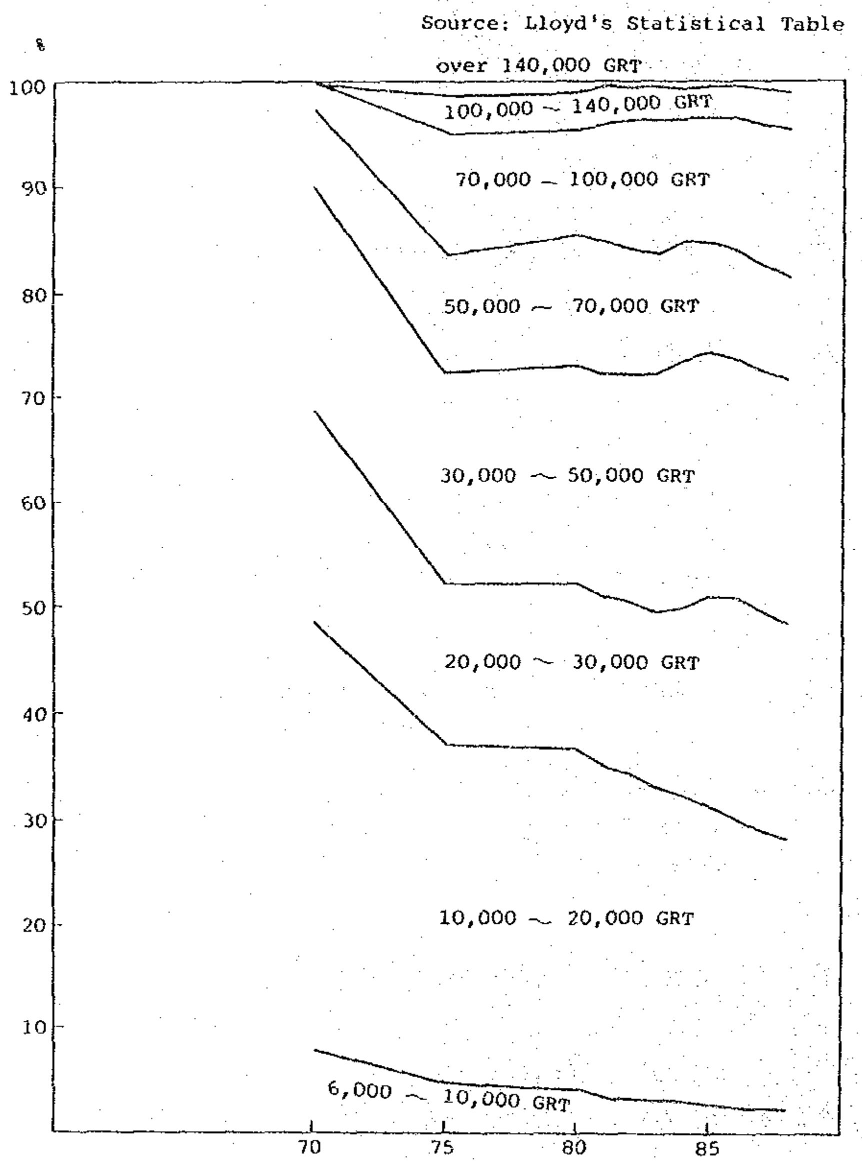


Fig. 7-1-15 Trend of Vessel Size Distribution of Ore and Bulk Carriers

Since 1975, the proportion of the freight space of the vessels below 20,000 GRT (33,000 DWT) decreased greatly and that between 50,000 GRT and 70,000 GRT (85,000 DWT and 120,000 DWT) decreased also.

The increased vessel size groups are as follows.

20,000 - 30,000 GRT (33,000 - 48,000 DWT)
30,000 - 50,000 GRT (48,000 - 85,000 DWT)
70,000 - 100,000 GRT (120,000 - 180,000 DWT)

3) Trend of World Seaborne Trade

The major commodities of dry bulk cargoes are iron ore, coal and food grains. Table 7-1-7 shows the trend of these major commodities.

The total dry bulk cargo trade in 1987 was 763 million tons of which the iron ore trade was 309 million tons, the coal trade was 272 million tons and the food grains trade was 182 million tons.

Table 7-1-8 shows the dry bulk cargo movement. The total dry bulk cargo movement in 1987 was 4,219 billion ton-miles. The movement of iron ore, coal and food grains is respectively 1,650, 1,567 and 1,002 billion ton-miles in 1987.

The iron ore trade gradually increased from 152 million tons in 1965 up to 327 million tons in 1979 and has been almost stable since then.

The coal trade increased from 59 million tons in 1965 to 210 million tons in 1981 and decreased slightly to 197 million tons at one point but recovered to 276 million tons in 1986. The trade in food grains also increased from 82 million tons in 1965 up to 182 million tons in 1979 and has been oscillating since then.

4) Forecast of Vessel Size Trend

From the data of Fearnley's "World Bulk Fleet", the share of vessel size during these 3 years is as follows.

Table 7-1-17 Share of Vessel Size

(Unit: Million DWT)

Classification of Vessel Size	1986	1987	1988
Total dry bulk Carriers	233.1	229.5	226.9
Ore bulk carriers	197.5	196.0	193.2
Combi carriers	35.6	33.4	33.7
Over 80,000 DWT Ore bulk carriers	42.6	46.4	46.3
" + Combi carriers	78.1	79.8	79.9
40,000 - 80,000 DWT Ore bulk carriers	64.7	63.1	63.5
Below 40,000 DWT Ore bulk carriers	90.2	86.5	83.4

According to the study of the Japan Marine Research Institute, the scrapped freight space of dry bulk carriers increased greatly from 1.5 million DWT in 1982, up to 3.2 million DWT in 1983, 4.6 million DWT in 1984, 7 million DWT in 1985 and 11 million DWT in 1986. This trend of increased scrapped freight space of dry bulk carriers shows that the freight space of dry bulk carriers greatly exceeds the required freight space for dry bulk transport. The average life time of dry bulk carriers is 21 years, which is longer than the life time of oil tankers, viz 12 years.

As Fig. 7-1-16 and Table 7-1-18 show, the forecast simulation is implemented and the results are summarized as follows.

Table 7-1-18 (a) Forecast of Scrapping of Dry Bulk Carriers

Unit: Million DWT

Vessel Size \ Year	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	2000
Total	17.5 (12.2)	14.7 (12.2)	14.1 (11.7)	9.5 (11.3)	9.6 (11.1)	10.2 (11.4)	11.2 (12.0)	12.2 (13.0)	13.2 (13.9)	13.9 (14.5)	14.5 (14.9)	15.0 (15.4)	15.5 (15.8)	16.0 (16.2)	16.4 (16.5)
Bulk Carriers (80,000DWT -)	1.7 (2.0)	2.7 (2.2)	2.9 (2.2)	1.9 (2.2)	2.0 (2.2)	2.1 (2.2)	2.3 (2.3)	2.4 (2.4)	2.4 (2.4)	2.3 (2.3)	2.3 (2.3)	2.3 (2.3)	2.3 (2.3)	2.3 (2.3)	2.4 (2.4)
Bulk Carriers (40-80,000DWT)	4.1 (1.7)	3.1 (1.9)	2.8 (1.9)	1.1 (1.9)	1.3 (2.0)	1.4 (2.0)	1.7 (2.2)	1.9 (2.4)	2.2 (2.5)	2.4 (2.6)	2.5 (2.7)	2.6 (2.8)	2.8 (2.9)	2.9 (3.0)	3.0 (3.0)
Bulk Carriers (-40,000DWT)	5.2 (2.1)	2.9 (2.2)	3.1 (2.3)	1.7 (2.3)	1.9 (2.4)	2.1 (2.5)	2.4 (2.8)	2.7 (3.0)	3.0 (3.3)	3.2 (3.5)	3.3 (3.6)	3.5 (3.7)	3.6 (3.8)	3.7 (3.8)	3.8 (3.9)
Combi-carriers	2.5 (1.8)	1.9 (1.9)	1.9 (1.7)	1.7 (1.7)	1.5 (1.6)	1.5 (1.5)	1.5 (1.6)	1.6 (1.7)	1.7 (1.8)	1.8 (1.9)	1.9 (2.0)	2.0 (2.0)	2.0 (2.0)	1.7 (1.7)	1.9 (1.9)
General Cargo Vessel	4.0 (4.7)	4.1 (4.1)	3.4 (3.5)	3.0 (3.1)	3.0 (3.0)	3.1 (3.0)	3.3 (3.2)	3.7 (3.5)	3.9 (3.8)	4.2 (4.1)	4.5 (4.4)	4.7 (4.6)	5.0 (4.9)	5.2 (5.1)	5.4 (5.3)

Note: ( ) Stands for Case II

Table 7-1-18 (b) Forecast of Ordering of Dry Bulk Carriers

Unit: Million DWT

Vessel Size \ Year	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	2000
Total	15.0 (15.0)	16.8 (15.7)	20.2 (18.5)	24.2 (21.5)	26.0 (23.9)	26.8 (25.7)	26.5 (26.3)	26.1 (26.4)	26.3 (26.8)	27.0 (27.6)	28.4 (28.9)	29.8 (30.3)	31.3 (31.9)	33.3 (33.6)	34.7 (35.3)
Bulk Carriers (80,000DWT -)	2.0 (2.0)	2.0 (2.1)	2.7 (2.8)	3.8 (3.7)	5.1 (5.0)	6.1 (5.9)	6.0 (5.7)	5.3 (5.0)	4.6 (4.5)	4.2 (4.1)	3.8 (3.8)	3.5 (3.4)	3.1 (3.0)	2.7 (2.7)	2.4 (2.4)
Bulk Carriers (40-80,000DWT)	2.8 (2.8)	3.0 (2.6)	3.5 (3.2)	4.1 (3.6)	4.4 (4.0)	4.5 (4.2)	4.6 (4.4)	4.6 (4.6)	4.7 (4.7)	4.9 (5.0)	5.1 (5.1)	5.2 (5.3)	5.4 (5.5)	5.5 (5.7)	5.8 (5.9)
Bulk Carriers (-40,000DWT)	4.0 (4.0)	4.8 (4.2)	6.5 (5.6)	8.5 (7.1)	9.1 (8.0)	9.2 (8.7)	8.8 (8.8)	8.6 (8.8)	8.7 (9.0)	9.0 (9.3)	9.6 (9.9)	10.3 (10.5)	10.9 (11.2)	11.6 (11.9)	12.4 (12.7)
Combi-carriers	1.7 (1.7)	1.7 (1.5)	1.6 (1.4)	1.3 (1.0)	0.9 (0.6)	0.5 (0.4)	0.5 (0.7)	1.1 (1.3)	1.6 (1.7)	2.0 (2.1)	2.4 (2.5)	2.9 (3.0)	3.4 (3.5)	3.9 (4.0)	4.4 (4.4)
General Cargo Vessel	4.6 (4.6)	5.2 (5.0)	5.9 (5.6)	6.4 (6.0)	6.5 (6.2)	6.5 (6.5)	6.5 (6.6)	6.5 (6.7)	6.7 (6.9)	6.9 (7.1)	7.5 (7.6)	8.0 (8.1)	8.6 (8.7)	9.2 (9.3)	9.9 (9.9)

Note: ( ) Stands for Case II

Table 7-1-18 (c) Forecast of Dry Bulk Carrier Freight Space

Unit: Million DWT

Vessel Size \ Year	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	2000
Total	365.9 (365.9)	367.0 (372.4)	364.3 (372.2)	364.6 (374.3)	372.4 (379.3)	383.5 (387.0)	396.7 (397.0)	409.4 (408.0)	420.0 (417.6)	428.7 (426.3)	436.4 (434.4)	444.0 (442.2)	451.5 (449.2)	459.1 (457.5)	467.8 (465.3)
Bulk Carriers (80,000DWT -)	42.6 (42.6)	45.7 (45.4)	45.1 (45.3)	44.2 (45.1)	44.7 (45.4)	45.8 (46.2)	47.8 (48.0)	50.3 (50.6)	52.9 (52.1)	55.1 (55.3)	56.9 (57.1)	58.6 (58.6)	60.0 (59.9)	62.0 (60.8)	63.8 (61.5)
Bulk Carriers (40-80,000DWT)	64.8 (64.2)	65.6 (68.0)	65.0 (68.7)	65.0 (69.5)	67.0 (70.5)	69.4 (71.8)	71.9 (73.4)	74.3 (75.0)	76.3 (76.4)	77.9 (77.7)	79.4 (79.0)	80.9 (80.3)	82.3 (81.5)	82.6 (82.8)	84.9 (84.0)
Bulk Carriers (-40,000DWT)	90.1 (90.1)	87.9 (91.1)	87.6 (91.5)	88.2 (92.7)	91.6 (94.9)	96.5 (98.3)	102.4 (102.7)	108.2 (107.6)	113.2 (112.1)	117.5 (116.4)	121.5 (120.5)	125.5 (124.5)	129.6 (128.7)	133.8 (132.7)	139.2 (137.4)
Combi-carriers	35.6 (35.6)	34.5 (35.2)	34.1 (34.9)	33.9 (34.6)	33.8 (34.3)	32.7 (34.0)	33.4 (33.3)	32.7 (32.4)	31.8 (31.3)	30.8 (30.3)	30.0 (29.5)	29.3 (28.9)	28.9 (28.6)	28.8 (28.6)	29.0 (28.8)
General Cargo Vessel	132.9 (132.9)	133.3 (132.6)	132.5 (131.8)	133.3 (132.5)	135.3 (134.3)	138.1 (136.7)	141.1 (139.5)	143.6 (142.4)	145.8 (144.7)	147.3 (146.7)	148.5 (148.3)	149.7 (149.8)	150.7 (151.1)	151.8 (152.4)	152.9 (153.7)

Note: ( ) Stands for Case II

Result of Simulation of World Dry Bulk Carriers

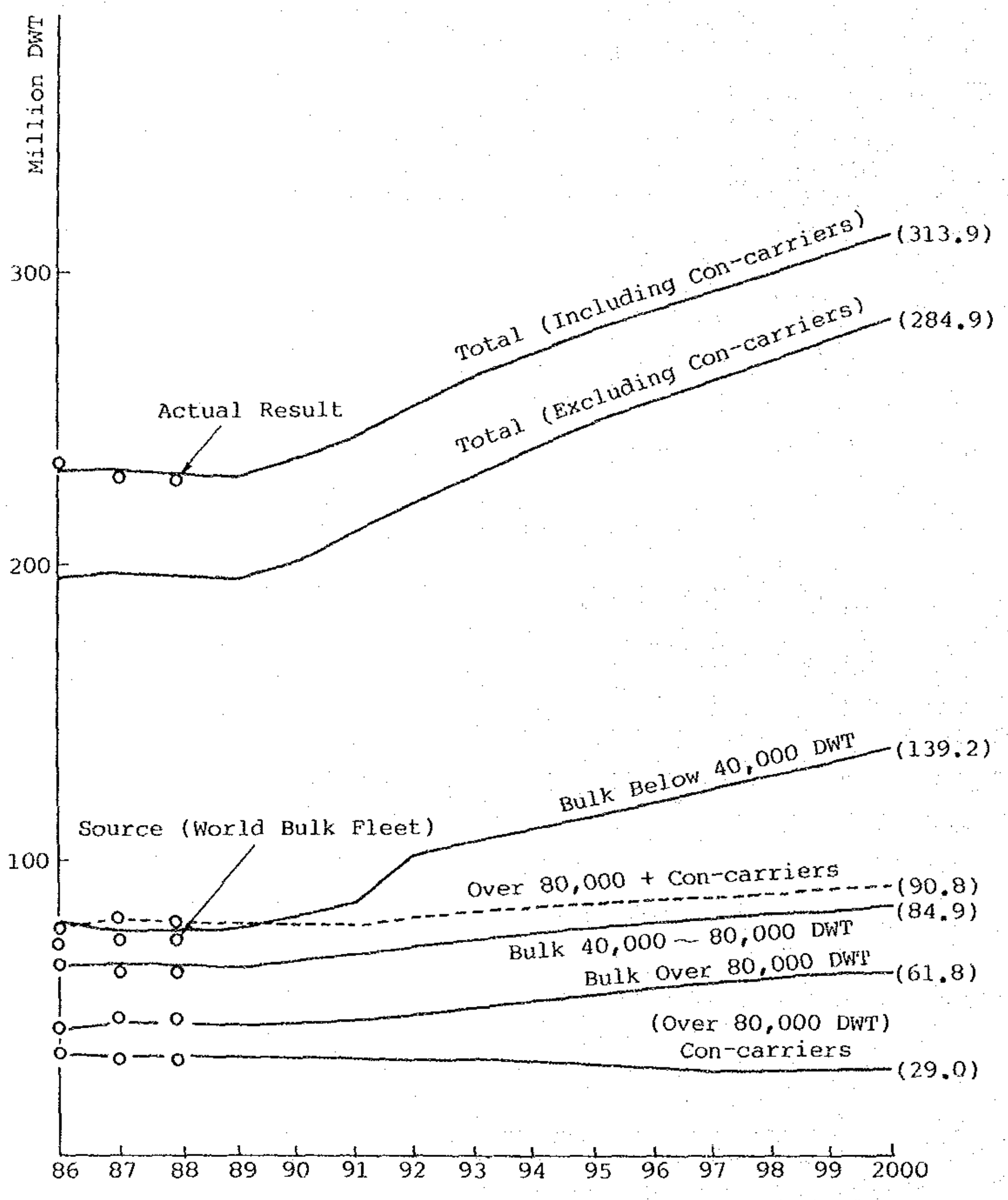


Fig. 7-1-16 (a) Result of Simulation

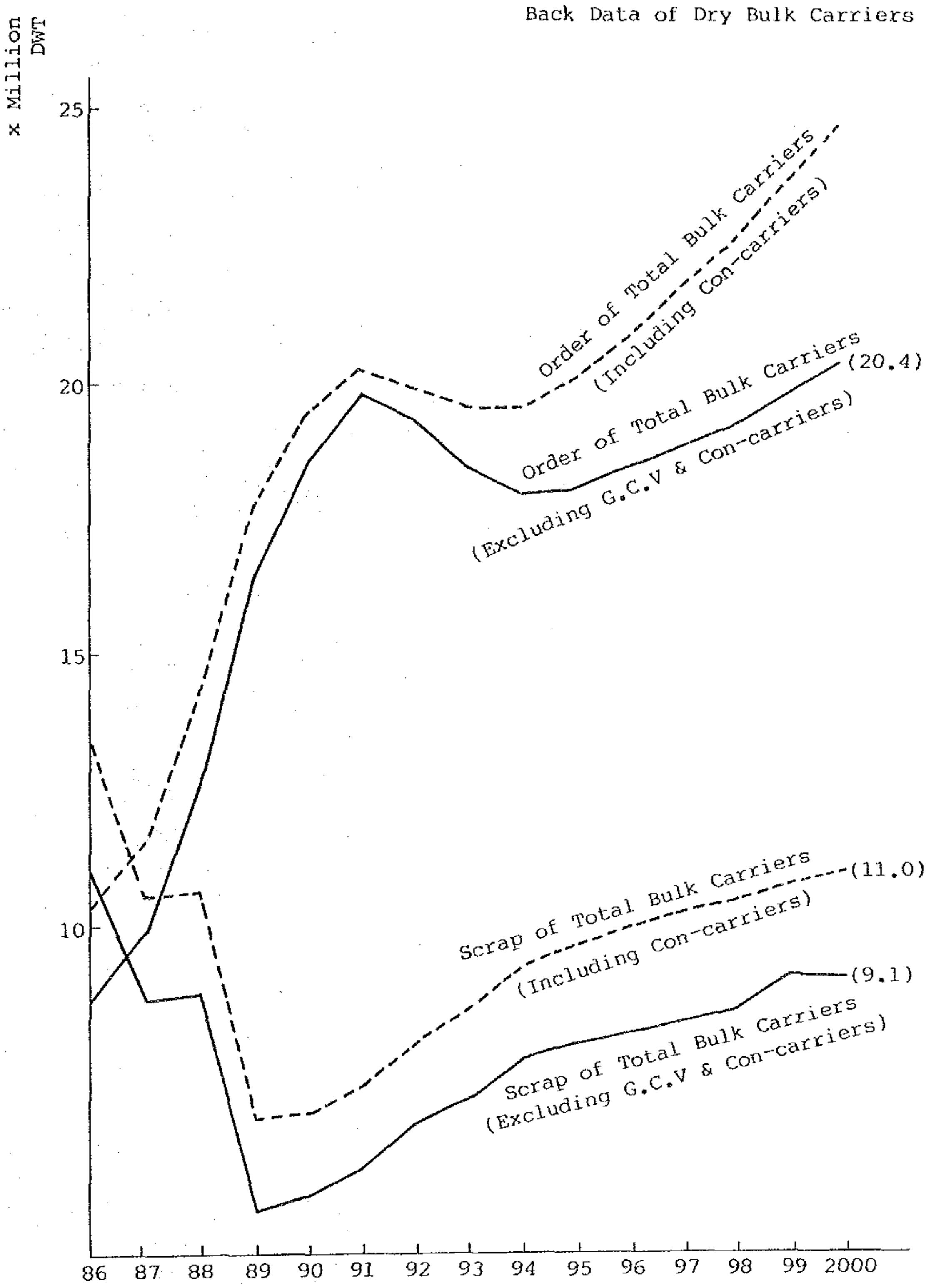


Fig. 7-1-16 (b) Result of Simulation

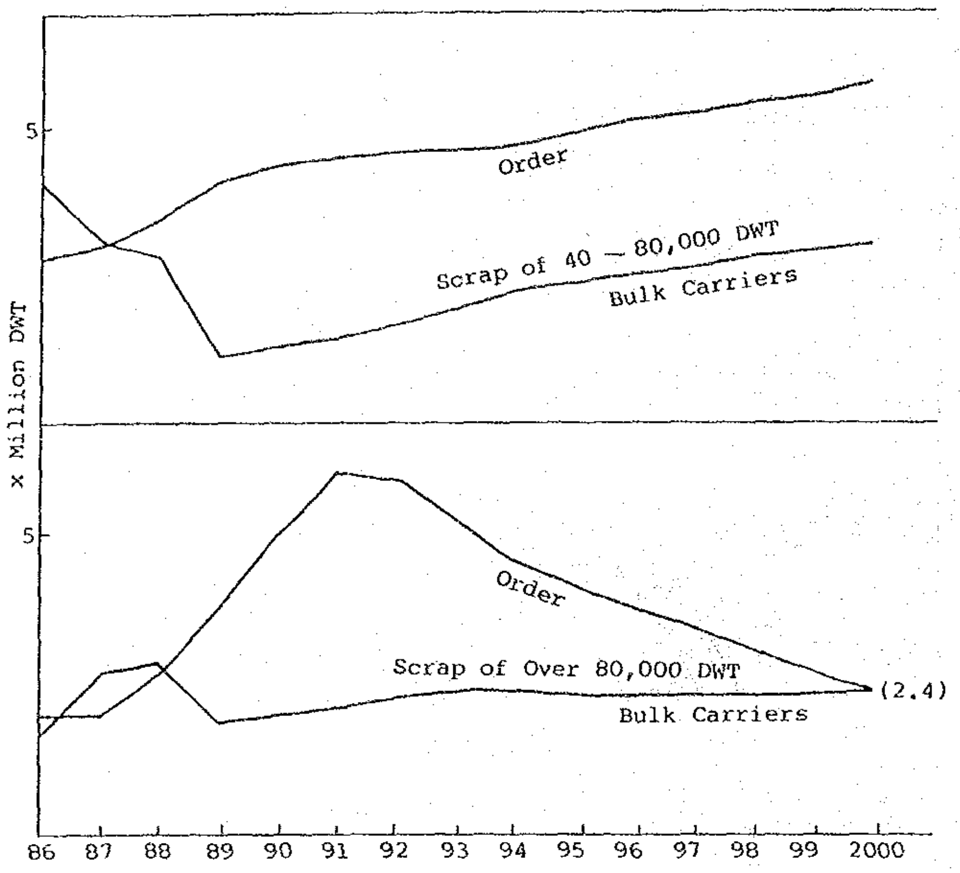


Fig. 7-1-16 (c) Result of Simulation

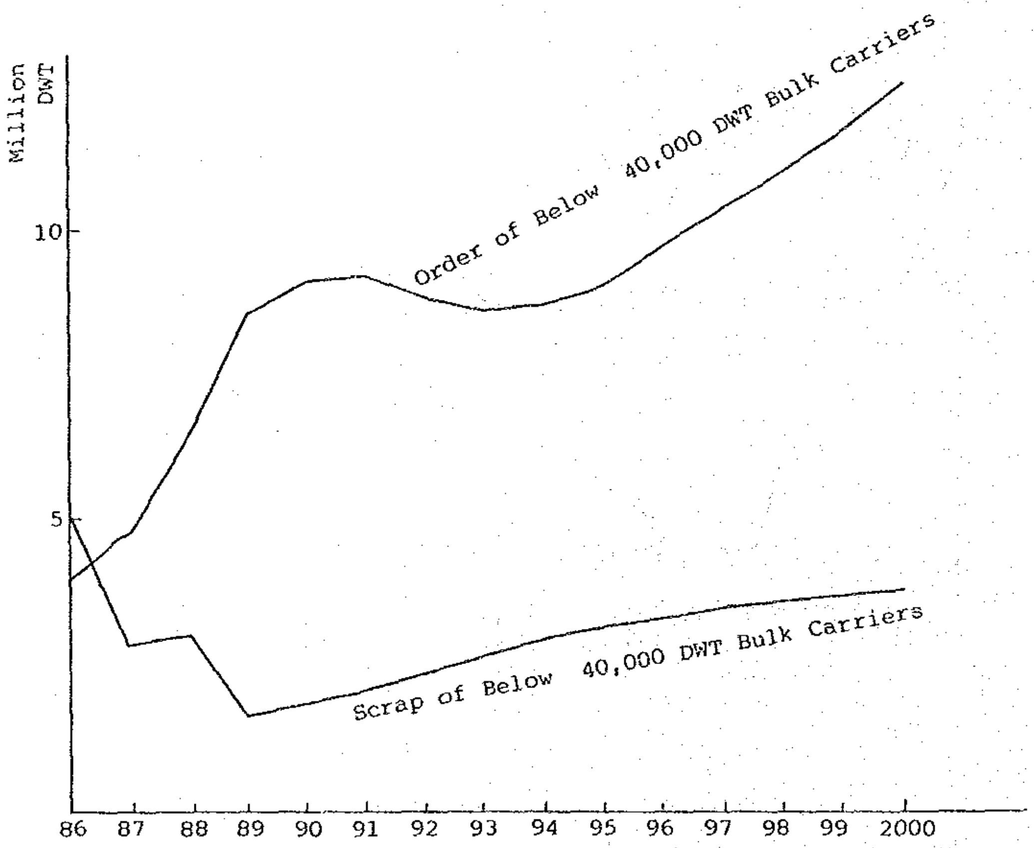


Fig. 7-1-16 (d) Result of Simulation

① The total freight space of ore and bulk carriers will increase from 226.9 million DWT in 1988 to 237.1 million in 1990, 281.4 million DWT in 1995 and 314.9 million DWT in 2000. The total freight space consists of the freight space of dry bulk carriers and combi-carriers.

② The total freight space of combi-carriers will gradually decrease from 33.7 million DWT in 1988 to 30.8 million DWT in 1995 and 29.0 million DWT in 2000. The share of combi-carriers to the total freight space will decrease from 14.9 % in 1988 to 9.2 % in 2000.

③ As Table 7-1-16 (b) shows, most combi-carriers exceed 80,000 DWT. So when we add the freight space of combi-carriers to the freight space of dry bulk carriers over 80,000 DWT, the total freight space over 80,000 DWT will increase from 79.9 million DWT in 1988 to 85.9 million DWT in 1995 and 90.8 million DWT in 2000. But the share of the freight space over 80,000 DWT will decrease from 35.2 % in 1988 to 30.5 % in 1995 and 28.8 % in 2000.

④ The freight space of ore and bulk carriers over 80,000 DWT excluding combi-carriers will increase from 46.2 million DWT in 1988 to 55.1 million DWT in 1995 and 61.8 million DWT in 2000. But the share over 80,000 DWT will decrease from 23.9 % in 1988 to 22.0 % in 1995 and 21.6 % in 2000.

⑤ The freight space of ore and bulk carriers between 40,000 DWT and 80,000 DWT will increase from 63.5 million DWT in 1988 to 77.9 million DWT in 1995 and 84.9 million DWT in 2000. But the share of this vessel class will decrease from 32.9 % in 1988 to 31.1 % in 1995 and 29.7 % in 2000.

⑥ The freight space of less than 40,000 DWT will rapidly increase from 83.4 million DWT is 1988 to 117.5 million DWT in 1995 and 139.2 million DWT in 2000. And the share of this vessel class will also increase from 43.2 % in 1988 to 46.9% in 1995 and 48.7 % in 2000.

(3) Container Vessels

1) Present Vessel Size Distribution

a) Proportion of Classified Vessel Size

Fig. 7-1-17 shows the container vessel size distribution in 1988. The number of container vessels between 15,000 DWT and 50,000 DWT is over half of the total. The other major vessel size class is between 5,000 DWT and 10,000 DWT.

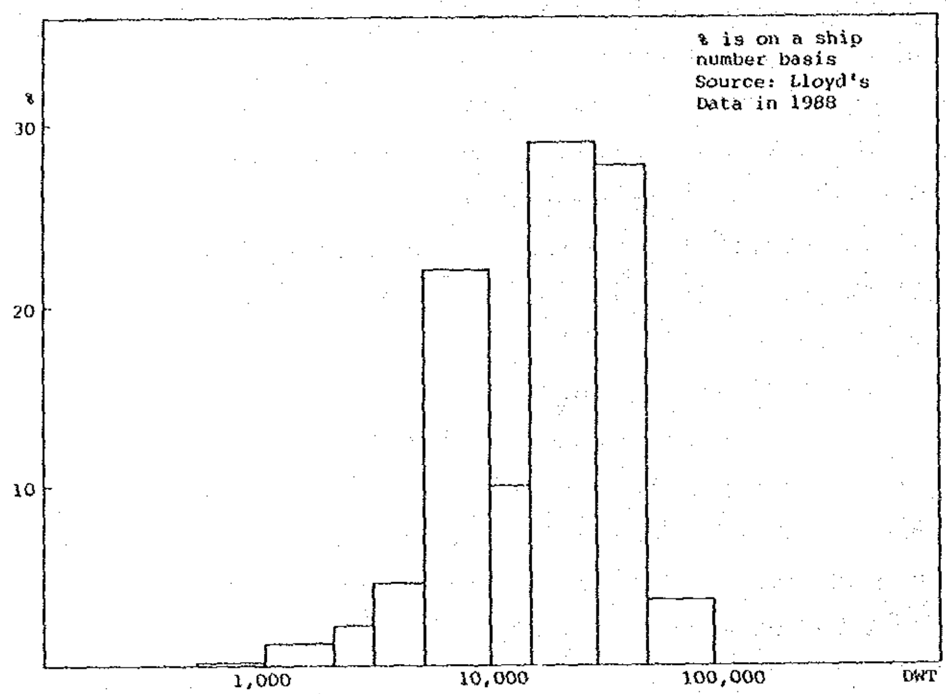


Fig. 7-1-17 Container Vessel Size Distribution

The following table shows the vessel size distribution in 1986 classified by container carrying capacity.

Table 7-1-19 Vessel Size Distribution in 1986

Range TEUs	No.	%	Total TEUs	%	Average TEU
Less than 500	372	35.0	104,515	8.7	281
500 - 999	204	19.1	147,051	12.3	721
1,000 - 1,499	162	15.2	199,148	16.7	1,229
1,500 - 1,999	144	13.5	248,035	20.8	1,722
2,000 - 2,499	78	7.3	176,176	14.7	2,259
2,500 -	107	10.0	319,994	26.8	2,991
Total	1,067	100.0	1,194,919	100.0	1,120

The proportion of fully cellular container vessels of less than 1,000 TEUs is over 50 % on a ship number basis but is only 20 % on a container carrying capacity basis. On the other hand, the proportion of over 2,000 TEUs is 17.3 % on a ship number basis but 41.5 % on a container carrying capacity basis.

b) Dimensions of Vessel Size

From the PHRI report, the following formulae are newly obtained regarding fully cellular container vessels.

$$\log L = 0.6124 + 0.3825 \log DWT \quad - (22)$$

$$\log d = -0.4500 + 0.3331 \log DWT \quad - (23)$$

$$\log B = 0.1201 + 0.3009 \log DWT \quad - (24)$$

The standard deviations and the coefficients of correlation of the above respective formulae are as follows.

Table 7-1-20 Standard Deviations and Coefficients of Correlation

No. of formula	σ	r
(22)	0.038	0.963
(23)	0.034	0.962
(24)	0.029	0.966

The following table shows the calculated dimensions of fully cellular container vessels by using the above formulae.

Table 7-1-21 Calculated Dimensions of Fully Cellular Container Vessels

DWT	L	d	B
	(m)	(m)	(m)
500	44.1	2.8	8.6
1,000	57.5	3.5	10.5
2,000	75.0	4.5	13.0
3,000	87.6	5.1	14.7
5,000	106.5	6.1	17.1
10,000	133.8	7.6	21.1
15,000	162.1	8.7	23.8
30,000	211.3	11.0	29.3
50,000	256.9	13.0	34.2
100,000	334.9	16.4	42.1

2) Trend of Fully Cellular Container Vessel Size

The following table shows the trend of average vessel size of container vessels during these 10 years.

Table 7-1-22 Trend of Average Container Vessel Size

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
No. of Vessels	594	662	707	718	786	940	1,011	1,064	1,093	1,115
GRT (x 1,000)	9,996	11,274	12,292	12,942	14,194	16,913	18,364	19,609	21,089	22,109
GRT Average Vessel Size	16,828	17,030	17,386	18,025	18,059	17,993	18,164	18,430	19,295	19,829

(Source: Lloyds Statistical Table)

The average vessel size has been increasing during these 10 years. The number of vessels also increased from 594 in 1979 to 1,115 in 1988.

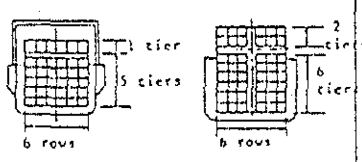
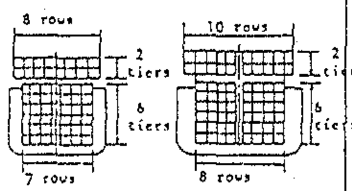
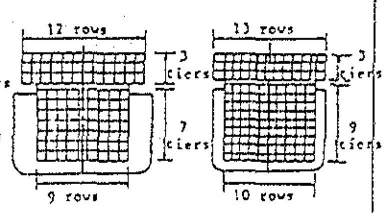
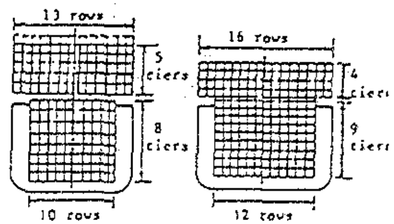
According to the presentation of Itsurou Watanabe, Mitsui Heavy Industries Ltd. Japan, containerization has entered the fourth generation. He summarized the progress of containerization chronologically in the following table.

The first generation saw the inception of the system. It can also be regarded as having been a trial period for further real development. Coastal container services by Sea-land, Matson, Seatrain, Alaska Steamship and so on in the United States and by Seatainer Service in Australia had started before 1966 in the First Generation. The vessel's capacities were in the range of 500 to 800 TEUs. Most of them were provided with self-sustaining gantry cranes on board to handle containers.

After containerization proved successful in producing a rationalized transport system, several major shipping companies in the USA made plans to containerize international trade in 1965. The first lift-on/lift-off full container ship, "FAIRLAND" of Sea-Land, pioneered the container service between the US east coast and Europe in April 1966. This marked the opening of the second generation. The range of container vessels was 700 to 1,500 TEUs.

Around 1971, long-distance international container services straddling several oceans, such as trade between Europe and the Far East and that between Europe and the West Coast of the USA, were inaugurated. Moreover, containerization was about to penetrate to developing countries in South-East Asia, the Middle East, South America and so on. It was the dawn of the third generation. In this generation, container ships having

Table 7-1-23 Progress of Containerization

	The First Generation	The Second Generation	The Third Generation	The Fourth Generation
Chronology	Age of domestic coastal services before 1966	Age of short international service across one ocean since 1966	Age of long international services through plural oceans since 1971	Age of round-the-world services since 1984
Examples of services	Coastal services in U.S.A. and Australia	Trans-Atlantic and trans-Pacific services	Services between Europe and Far East, and U.S. West Coast and Europe	Round-the-world services by U.S.L. and Evergreen
Territories Containerised	U.S.A., Australia	Advanced countries such as U.S.A., Europe, Australia, Japan, etc.	Developing countries in South-East Asia, Middle-East, South America, etc.	World-wide including China, India and Countries in Africa
Containers	Pre-ISO Standard size ... 17', 24', 35' long	ISO Standard size ... 8/8'-6' x 8x20'/40'	High cube type ... 9', 9'-6' high	Deviation from ISO Standard size ... 45', 48' long
Container-ships	Mainly, converted ships with on-board cranes "Gateway City" 135.7mx22mx7.7m 7,785DWT on-board crane "Hawaiian Citizen" 141.8mx21.3mx9m 10,282 DWT  35'-60(deck)+35'-166(hold) total 35'-226 24'-112(d)+24'-296(h) 24'-408 Semi-containerships also engaged.	Purpose-built Ships of 700 ~ 1,500 TEU capacity "America Maru" 175mx25mx9.5m 15,440 DWT "Hakozaki Maru" 200mx30mx9.5m 19,914 DWT  228 TEU(d)+488TEU(h) 716 TEU 354 TEU(d)+656 TEU(h) 1010 TEU Ro/Re-ships also appeared	Purpose-built ships over 2,000 TEU capacity (Panamax size) "Kurobe Maru" 242mx32.2mx10.5m "Frankfurt Express" 271mx32.2mx13.0m  850 TEU(d)+979 TEU(h) 1825 TEU 1105 TEU(d)+1940TEU(h) 3045 TEU LASH and Seabee appeared and disappeared	Purpose-built ships over 3,000 TEU capacity (Possibility of over-Panamax size) "ECONOSHIPS" 279mx32.2mx11.65m 57,800 DWT "Over-Panamax" (Planned) 39.6m (Breadth)  996 FEU(d)+1232FEU(h) 2228 FEU about 5500 TEU
Quay-side container cranes	Alameda, Matson Terminal Rated capacity 25.4t, 30-5m/min(hoist) x175m/min(traverse) Total weight 350t, 27.85m(outreach) x10.37m(span) x15.63m(clear lift)	Kobe, Maya-Pier 25.4t, 30x130 464t, 33.5x16x19.5 Yokohama, Honmoku 30.5t, 36x160 600t, 32x30x21	Yokohama, Honmoku 30.5t, 49x152 640t, 36.1x30x27 Telescopic spreader Brisbane, BATL 36t, 40x152 850t, 37.3x25.3x29 Telescopic spreader	Rotterdam, ECT 55t, 50x210 1250t, 50x35x30 with 2nd trolley 60 cont/hour Tacoma, Sea-Land 40.6t (48.8t in future) 1000t, 39.9x30.5x47
Container terminals	Straddle carriers, Clark-525, 1 over 1, 165 PS (24')	Mitsubishi Vsc20, 1 over 1, 180 PS (20') " Vsc40, 2 stacking, 190 PS (40')	Mitsubishi Vsc2023 (20') 2 over 1, (40') 2 stacking, 180 PS " Vsc4023, 2 over 1, 200 PS (20'/40')	Mitsubishi Vsc4233, 3 stacking, 2x200 PS, (20'/40') Nellen 904, 4 stacking, 2x180 PS (20'/40')
	Transfer cranes, (2 cont. lanes + 1 traffic lane) x 2 over 1	(6 + 1) x 3 over 1	(6+1) x 4 over 1 (semi-automatic)	
	Large forklift trucks, Yard use tractors	Top-lift trucks, Side loader		
		Computerised	Computerised, Semi-automatic operation	Computerised, Advanced automatic operation
Remarks			Feeder service networks land-bridge operation	NVOCC Integrated service of surface with air transport

capacities of 2,000 TEUs appeared. However, the tend towards high-speed container ships ceased upon the occurrence of the oil shock in 1973.

In order to compete with the new comers established in developing countries, the traditional container operators come to serve many ports in developing countries on the trade routes in addition to limited ports of call in existing services. Thus, networks providing feeder services were sometimes reorganized in accordance with the change in the ports of call of trunk line services. Taking into consideration the latest problems, a new strategy to be adopted by container operators in the fourth generation is anticipated, revolving round the following three points:

① The size of container ships will tend to be enlarged to over 3,000 TEU capacity, and the restriction on ship sizes imposed by the Panama Canal will be ignored.
② Trunk line services by large capacity ships will select a very limited number of major ports.
③ Round-the-world services will be inaugurated

Actually in 1985, United States Lines (USL) introduced ships with capacities of over 4,000 TEU, equipped exclusively to carry forty foot containers. These ships were built to the same dimensions as 3rd generation ships, the additional capacity being achieved by stacking containers five high on deck. USL has employed these vessels on a new Round-the-world service. The most revolutionary change in container ship design in recent years came in 1986 when American President Lines (APL) ordered vessels with greater than Panama Canal dimensions and with a capacity of about 3,800 TEUs. The beam of these vessels will be approximately 40 meters (16 boxes) across as compared with a maximum of 32 meters (13 boxes) for all previous container ships.

The following table shows the selected container vessels-dimensions, capacity and speed.

Table 7-1-24 Selected Container Vessels-Dimensions, Capacity and Speed

Name	Year	LOA m	LBP m	Beam m	Depth m	Draft m	DWT t	TEU	Power shp	Spd k
Fairland	1957		137	22.0		7.6	7,865	226	6,500	16
Elbe Express	1968		171	24.6		7.9	11,172	736	15,750	19
Euroliner	1972		243	30.6		10.7	28,443	1,632	58,600	26
Liverpool Bay	1972	290	274	32.3	24.6	13.0	48,544	2,961	50,880	23
Bremen Express	1972	290	279	32.3	25.0	12.7	47,838	2,952	81,100	23
Benalder	1972	290	273	32.3	21.2	13.0	49,593	2,804	51,380	
Toyama	1972	290	276	32.3	24.0	11.9	34,033	2,422	78,200	26
Selandia	1972	290	273	32.3	23.9	11.9	40,824	2,774	78,600	26
Nihon	1972	289	273	32.3	23.9	11.9	40,912	2,420	78,500	26
Nedlloyo Dejimr	1973	287	273	32.3	20.5	12.7	43,211	2,952	50,880	25
Korrigan	1973	289	274	32.3	24.6	10.9	48,850	2,960	53,600	22
Transuaal	1978		259	32.3		13.0	49,730	2,434	53,280	23
Sealand Explorer	1980		227	30.7		9.5	23,676	839	30,150	22
Ever Large	1980		203	30.1		11.2	28,904	1,800	22,260	18
Cast Husky*	1982		234	32.3		13.5	70,000	1,466	13,600	14
American Kentucky	1985	290	279	32.3	21.5	11.7	58,500	4,258	28,000	18

* Containers and bulk
Source: UWIST

3) Trade of World Seaborne trade

The following table shows the world container port traffic from 1975 to 1987. The total container port traffic around the world was over 65 million TEUs in 1987 compared with 17 million TEUs in 1975. The increase rate during this period was 11.7 %. During 1975 to 1981, the increase rate was 15.3 %, on the other hand that during 1981 to 1987 was 8.3 %.

The following table shows the comparison of the regional share of container port traffic in 1975, 1981 and 1987.

The largest share of container port traffic in 1975 was in North America followed by Europe, but in 1987 the number one region become Far east and Asia. During 1975 to 1987, the regions where the increase rate exceeded the average increase rate were Far East and Asia, Middle East, Africa and Others. During 1981 to 1987, the regions showing high growth were Far East and Asia, and Central and South America.

Table 7-1-26 Regional Container Traffic

(Unit: Thousand TEUs)

Region	1975		1981		1987		Increase Rate (12 Years)	Increase Rate 1975-81	Increase Rate 1981-87
		%		%		%	%	%	%
1 Far East & Asia	3,726	21.4	9,953	24.4	22,251	33.8	16.1	17.8	14.3
2 Central and South America	921	5.3	1,065	2.6	1,856	2.8	6.0	2.5	9.7
3 Middle East	134	0.8	1,870	4.6	2,358	3.6	27.0	55.2	3.9
4 Africa	63	0.4	734	1.8	659	1.0	21.6	50.6	-1.8
5 North America	5,708	32.8	9,199	22.5	14,138	21.5	7.9	8.3	7.4
6 Europe	5,152	29.6	11,376	27.8	15,751	23.9	9.8	14.1	5.6
7 Australia & South Pacific	816	4.7	1,545	3.8	1,394	2.1	4.6	11.2	-1.7
Others	890	5.1	5,109	12.5	7,437	11.3	19.4	33.8	6.5
Total	17,410	100.0	40,851	100.0	65,844	100.0	11.7	15.3	8.3

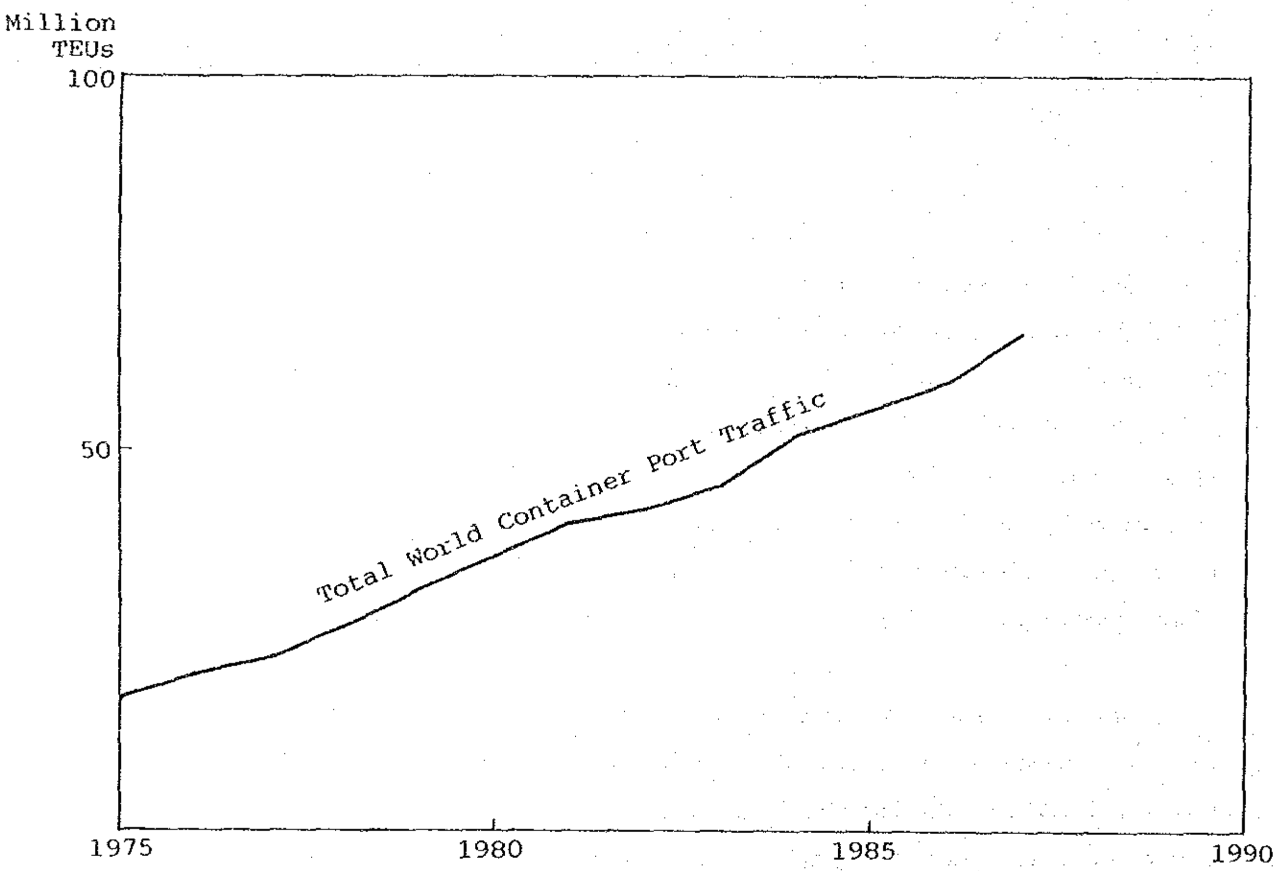


Fig. 7-1-18 Trend of Total container Port Traffic

Table 7-1-25 World Container Port Traffic by Country

(Unit: Thousand TEUs)

Region	Country	Ranking	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Far East & Asia	Japan	2	1,868	2,380	2,709	2,918	2,897	3,320	3,737	3,754	4,106	4,758	5,517	5,616	5,952
	Taiwan	3	471	656	747	1,043	1,341	1,644	1,788	1,902	2,429	3,027	3,075	4,105	4,772
	Hong Kong	4	802	1,029	1,259	1,226	1,304	1,465	1,560	1,660	1,837	2,109	2,289	2,774	3,457
	Singapore	7	221	312	374	539	699	917	1,065	1,116	1,274	1,552	1,699	2,203	2,635
	South Korea	9	189	264	498	554	626	688	803	862	978	1,178	1,246	1,448	1,949
	Philippines	18	95	134	169	210	354	426	553	685	722	658	639	742	908
	Thailand	22	14	59	73	120	164	181	242	259	305	341	400	511	650
	Malaysia	26	66	83	100	123	152	172	205	234	291	376	389	402	462
Central & South America	Puerto Rico	15	877	875	786	1,113	803	852	842	935	911	918	881	930	1,199
	Brazil	21	44	56	46	78	35	43	223	265	364	529	612	514	657
Middle East	Soudi Arabia	19	-	-	274	499	710	818	914	1,049	1,187	1,176	947	823	830
	United Arab Emirates	17	-	-	91	190	259	340	440	411	501	598	712	920	954
	Israel	31	134	169	199	237	268	279	293	304	336	331	308	344	374
	Kuwait	40	-	-	59	91	122	171	223	284	250	258	236	201	200
Africa	South Africa	20	63	114	146	323	457	570	734	661	652	762	633	617	659
North America	USA	1	5,270	5,723	5,477	6,173	7,243	8,618	8,363	8,730	9,477	11,059	11,533	12,317	12,849
	Canada	14	438	491	626	629	749	789	836	767	839	1,005	1,068	1,147	1,289
Europe	UK	5	1,393	1,535	1,774	1,986	2,300	2,236	2,283	2,575	2,768	2,896	2,886	3,005	3,437
	Netherlands	6	1,139	1,298	1,404	1,696	1,872	2,082	2,240	2,302	2,423	2,666	2,769	3,042	2,918
	German Fedral Republic	8	736	878	979	1,177	1,332	1,493	1,725	1,690	1,758	2,054	2,152	2,254	2,503
	Italy	12	318	445	604	824	1,021	1,074	1,272	1,241	1,368	1,606	1,525	1,145	1,420
	Belgium	10	492	524	597	636	871	915	1,034	1,028	1,214	1,469	1,470	1,535	1,655
	France	13	393	543	628	715	928	1,071	1,280	1,215	1,165	1,291	1,485	1,470	1,344
	Spain	11	267	333	593	559	689	766	864	1,075	10,75	1,318	1,508	1,457	1,548
	Sweden	25	205	234	256	275	346	315	346	422	417	453	471	467	501
	Denmark	28	209	201	215	241	304	318	332	353	346	423	420	397	425
Australia & South Pacific	Australia	16	745	755	852	854	1,162	1,245	1,254	1,267	1,205	1,343	1,413	1,377	987
	New Zealand	29	71	88	168	222	252	347	291	328	329	365	405	388	407
World Total			17,410	20,263	22,992	27,039	31,986	36,510	40,851	42,845	45,957	52,715	55,903	59,449	65,844
				16.3	13.5	17.6	18.3	14.1	11.9	4.9	7.3	14.7	6.0	6.3	10.8
	People's Republic of China	23									192	249	446	533	519
	India	24									235	296	393	458	518
	Sri Lanka	27									121	181	216	341	429

4) Forecast of Vessel Size Trend

According to the Study on Container Shipping and Ports Study for Developing Member Countries by ADB, the vessel type in the future is estimated as follows.

Table 7-1-27 Vessel Type in the Future

Vessel Type		1987		1990		1995		2000	
	TEUs		%		%		%		%
V1	0 - 800	16,936	46.0	21,386	42.8	13,925	22.2	19,402	23.2
V2	800 - 1,600	7,848	21.3	11,182	22.4	10,919	17.4	13,209	15.8
V3	1,600 - 2,400	5,950	16.2	8,849	17.7	2,505	4.0	8,160	9.8
V4	2,400 - 3,200	6,089	16.5	8,552	17.1	35,464	56.5	42,913	51.3
Total		36,823	100.0	49,969	100.0	62,810	100.0	83,684	100.0

The main findings through the Study are as follows.

① Container trade will increase very substantially in the coming years. Following an annual growth rate of 10 percent per year from 1984 to 1987, container traffic is projected to continue its rapid growth until the mid 1990's, averaging about 12 percent per year, followed by a reduced annual growth of 6 percent to 2000. This represents a threefold growth in traffic from the present level.

② This growth will come both from increased trade, and from increased containerization, the former being more significant for developed countries, the latter for developing countries.

③ There is an already established trend towards increased number of larger sized cellular vessels - with calls by vessels of 2,400 - 3,200 TEU capacity rising from around 16 % to over 50 % of the total by 1995. These larger units will be phased in, leading to the redeployment and ultimately the faster retirement of older, smaller vessels.

④ The fleet serving the Asian region will need to grow from its present levels of 674 vessels to about 1,100 in 1995 and 1,500 in 2000.

(4) General Cargo Vessels

1) Present Vessel Size Distribution

a) Proportion of Classified Vessel Size

Fig. 7-1-19 shows the general cargo vessel size distribution in 1988. The largest class of general cargo vessels is in the range between 5,000 and 10,000 DWT, followed by the 1,000 - 2,000 DWT class.

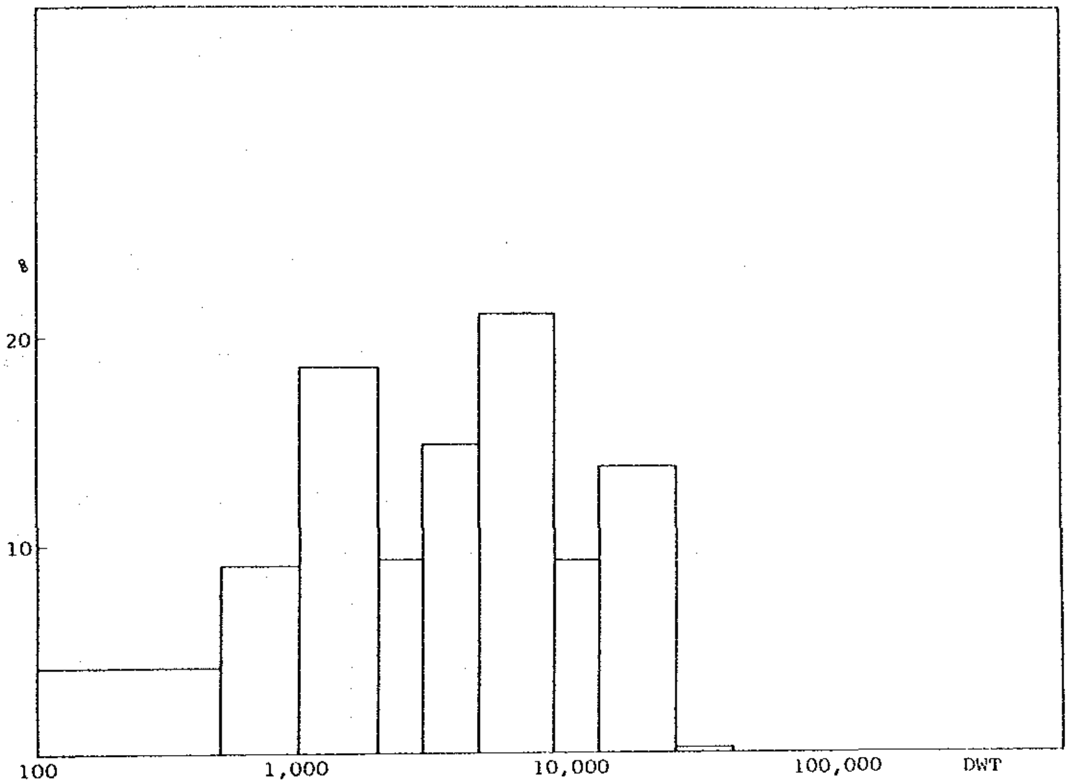


Fig. 7-1-19 General Cargo Vessel Size Distribution

b) Dimensions of Vessel Size

From the "PHRI" report the following formulae regarding general cargo vessels are obtained.

$$\log L = 0.654 + 0.362 \log DWT \ (< 5{,}000 \ DWT) \quad - (25)$$

$$\log L = 0.947 + 0.297 \log DWT \ (\geq 5{,}000 \ DWT) \quad - (26)$$

$$\log d = -0.305 + 0.301 \log DWT \ (< 5{,}000 \ DWT) \quad - (27)$$

$$\log d = -0.173 + 0.268 \log DWT \ (\geq 5{,}000 \ DWT) \quad - (28)$$

$$\log B = 0.048 + 0.303 \log DWT \ (< 5{,}000 \ DWT) \quad - (29)$$

$$\log B = 0.183 + 0.271 \log DWT \ (\geq 5{,}000 \ DWT) \quad - (30)$$

The standard deviations and the coefficients of correlation of the above formulae are as follows.

Table 7-1-28 Standard Deviations and Coefficients of Correlation

No. of formula	σ	r
㉕	0.029	0.954
㉖	0.034	0.919
㉗	0.038	0.895
㉘	0.028	0.929
㉙	0.029	0.935
㉚	0.031	0.920

By using the above formulae, the dimensions of general cargo vessels can be calculated as follows.

Table 7-1-29 Calculated Dimensions of General Cargo Vessels

DWT	L	d	B
	(m)	(m)	(m)
500	42.8	3.2	7.3
1,000	55.0	4.0	9.1
2,000	70.6	4.9	11.2
3,000	81.8	5.5	12.6
5,000	111.1	6.6	15.3
10,000	136.5	7.9	18.5
15,000	153.9	8.8	20.6
30,000	189.1	10.6	24.9
50,000	220.1	12.1	28.6

2) Trend of General Cargo Vessel Size

The following table shows the trend of average vessel size of general cargo vessels during these 10 years.

Table 7-1-30 Trend of Average General Cargo Vessel Size

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
No. of Vessels	22,744	22,995	22,438	22,487	22,308	21,797	21,309	20,403	19,976	19,638
GRT (x 1,000)	81,678	82,610	80,826	80,542	79,323	77,174	75,783	73,245	72,166	71,863
Average Vessel Size	3,591	3,592	3,602	3,582	3,556	3,541	3,556	3,590	3,613	3,659

(Source: Lloyds Statistical Table)

The average vessel size has been almost stable during these 10 years, although the number of vessels decreased from 22,744 in 1979 to 19,638 in 1988.

7-2 Trend of Maritime Container Traffic in the Region

7-2-1 Present Container Shipping

Presently, Calcutta and Haldia Dock Systems are served predominantly by feeder vessels from/to Colombo, Singapore and Madras. Occasionally, mainline vessels are also operated to Haldia, but presently their numbers are minimal. Present container shipping services operated through Calcutta and Haldia are presented in Table 7-2-1 and 7-2-2 respectively.

Table 7-2-1 Container Shipping Service
(Calcutta as of 1987/88)

Shipping Line	Nature of Service	Frequency	Vessel Size	Draft
			TEUs	m
COBRA	Feeder (Colombo, Chittagon)	Fortnightly	548	7.5
BXCL	Feeder (Colombo, Madras, Chittagon)	Fortnightly	418	5.4
CSL	Feeder (Colombo, Madras, Chittagon)	Fortnightly	352	
DSR	Feeder (Colombo)	Fortnightly	404	7.9
ISS	Feeder (Singapore)	Every 20 days	318	7.5
SCI	Feeder (Madras)	Fortnightly	570	6.4
Orient Express Line	Feeder (Madras, Colombo, Singapore)	Fortnightly	218	5.3
ISS	Feeder (Singapore)	Fortnightly	343	6.5

Source: CPT

Table 7-2-2 Container Shipping Service (Haldia)

	Shipping Line	Nature of Service	Frequency	Vessel Size
1	Shipping Corpn. of India (India)	Main Line/ Feeder Service	Fortnightly	CAP. 400 TEUs (Geared)
2	Cobra Consortium (Europe/Australia Continent)	Feeder Service	Variable	CAP. 500 TEUs (Geared)
3	Black Sea Shipping (Russian)	Main Line/ Feeder Service	Fortnightly (Variable)	CAP. 500 - 900 TEUs (Geared/Gearless)
4	India Steam-ship Co. (India)	Feeder Service	Monthly (Variable)	CAP. 400 TEUs (Geared)
5	DSR Lines (East Germany)	Feeder Service	Variable	CAP. 400 TEUs (Geared)
6	Bengal Express	Feeder Service	Variable	CAP. 400 TEUs (Geared)

Source: EIL Report

It is noteworthy that the slot capacity of feeder vessels to/from Calcutta is at present 300 - 400 TEUs in the main with two exceptions, one being 548 TEUs (presumably only partly laden to/from Calcutta judging from the available draft) the other being 570 TEUs (ro-ro vessel, after discharging at Haldia), while at Haldia vessels with a carrying capacity of 400 TEUs are prevailing.

In addition, most of the vessels calling at Calcutta and Haldia are at present geared vessels known as "self-sustaining ships".

7-2-2 Future Trend of Container Shipping

The recent growth of containerization in developing countries largely owes to the development of regional feeder service networks connecting smaller ports with hub ports which are served by mainline container vessels. This system has facilitated the expansion of container transport to ports in developing countries which cannot be served by mother (mainline) container vessels because of low throughput, insufficient facilities and poor geographical location relative to the mainline routes.

Containerization in South Asian countries has also grown through the development of a regional feeder network. Container vessels began calling at some ports in the region before 1970, stopping en route between Japan and North America and also between Europe and Australia, but it was only in the 1970's that containerization in the region began to rapidly accelerate with the development of feeder service networks.

The development of container terminals at the Port of Colombo also promoted increased container transport, and brought about a reorganization of the feeder service network in south Asia.

With the growth of the maritime trade and container penetration as well as the development of container terminals, it is expected that feeder service networks in the Region will be farther reorganized in the future.

As owners seek to optimize schedules and cargo volumes, and to minimize costs, feeder vessel sizes are likely to be increased and frequencies improved.

It is not possible to designate a size range for feeder vessels. Relatively large feeder ships of about 1,000 TEU also operate to Manila while much smaller feeder vessels of 100-200 TEU are found on some trade routes in Asia.

In this connection, a Singapore based shipping company indicated in its forecast that size of 500 TEUs effective capacity for short range and 1,000 TEUs for medium range will be the feeder of the future in South Asia (Feeder Operations in the Region, 6 July 88). A simple calculation of the maritime transport cost per TEU between Haldia and Colombo/Singapore also reveals the diminishing nature of the scale economies, i.e, the unit cost decreases remarkably by shifting from 350 TEUs to 500 TEUs loaders while the difference in terms of the unit cost between 500 TEUs loaders and 1,000 TEUs loaders is around 10 % with no appreciable improvement in the case of over 1,000 TEUs.

Judging from container throughput at Haldia/Calcutta in the future, they may primarily remain as the feeder ports with the increased vessel sizes as stated above, however, direct services could also be expected to increase in some trade routes where the traffic sufficiently increases and the efficiency of the port improves as analyzed below.

The possibility of the direct services to Haldia largely depends upon each shipping line's management policy. Generally speaking, when a shipping line makes a decision to have vessels call at a new port, the following points are deeply considered. (1) total cargo prospects in the future (2) balance of inward and outward cargo movement (3) expected gross revenue per call (4) geographical location of the port (5) port and terminal facilities and service level so that a vessel can call punctually and safely (6) berth priority : exclusive, preferential, or "first come, first served" basis, in order to maintain the schedule of "Fixed day of the week service (FDWS)." (7) systematic flow of operation in the terminal: from ship's operation to CY, CFS, gates and vice-versa with perfect information being confirmed by documentation using computers if possible (8) calculation of profit/loss on all earnings and payments including vessel cost, port and terminal charges, agents' fees, etc.

As described above, there are many points to be examined when contemplating the possibility of direct services at Haldia. However, as Calcutta and Haldia are already served by feeder vessels, it is considered likely that a cost comparison of using mother vessels or feeder vessels, namely whether or not the transport cost of containers by mother vessels calling at Haldia directly is less than that by feeder vessels calling at Calcutta directly will be an important issue. The calculation was carried out for mother vessels of 500 TEU, 1,000 TEU and 1,400 TEU and for feeder vessel of 350 TEU. The results of the calculation are presented in Table 7-2-3.

In case of the mother vessels, needless to say, it is necessary to add drayage cost from Haldia to Calcutta to the vessels' transport cost, and therefore container cargo landed at Haldia from mother vessels have to be drayed to Calcutta by truck, rail or barge at additional cost. The drayage cost from Haldia to Calcutta is expected to be $ 144 per TEU in the long term future as calculated in other section. It is assumed herein that the drayage cost by trucks would be reduced to a similar levels to the IWT transport in the future if the transport link is improved as suggested in the same section.

From this drayage cost and the transport cost indicated in Table 7-2-3, it is evident that the transport cost of containers to Calcutta via Haldia by direct services is less costly than that to Calcutta by feeder vessels, if the handling volume per vessel increases to some extent, for

Table 7-2-3 Comparative Cost of Serving Calcutta Directly by Feeder Vessel or Serving Haldia Directly by Mother Vessel

Size of Vessel, Handling Volume per Vessel	Cost of Direct Calling			Feeder Vessel Cost
	Mother Vessel Addtional Cost	Drayage Cost Haldia/Calcutta	Total Cost	
1. 500 TEU Size				
i) From Colombo				
600 TEU	95	144	239	225
900 TEU	63	144	207	225
ii) From Singapore				
600 TEU	127	144	271	251
900 TEU	85	144	229	251
2. 1,000 TEU Size				
i) From Colombo				
600 TEU	161	144	305	225
900 TEU	108	144	252	225
1,200 TEU	84	144	228	225
1,500 TEU	71	144	215	225
1,800 TEU	59	144	203	225
ii) From Singapore				
600 TEU	212	144	356	251
900 TEU	141	144	285	251
1,200 TEU	110	144	254	251
1,500 TEU	91	144	235	251
1,800 TEU	76	144	220	251
3. 1,400 TEU Size				
i) From Colombo				
600 TEU	206	144	350	225
900 TEU	137	144	281	225
1,200 TEU	108	144	252	225
1,500 TEU	91	144	235	225
1,800 TEU	75	144	219	225
2,100 TEU	68	144	212	225
2,400 TEU	59	144	203	225
ii) From Singapore				
600 TEU	276	144	420	251
900 TEU	184	144	328	251
1,200 TEU	143	144	287	251
1,500 TEU	118	144	262	251
1,800 TEU	99	144	243	251
2,100 TEU	87	144	231	251
2,400 TEU	87	144	221	251

(Note) Feeder vessel cost by 500 TEU loaders does not appreciably change if the fare share of the dredging and port traffic facility costs are added.

Table 7-2-4

A Feeder Ship

1. Ship size : 350 TEU
2. Handling rate by ship gear at Calcutta : 200 TEU/day
3. Handling volume per ship : 600 TEU
4. Route : Colombo/Calcutta/Colombo, Singapore/Calcutta/Singapore
   round basis
5. Charterage : $ 4,000 per day
6. Bunker Consumption : F.O. 16 K/T per day ($ 78.50 per K/T)
   D.O. 1 K/T per day ($154 per K/T)
7. Speed : 14 knots
8. Port charge : $ 2,500 per port
9. Transhipment charge (load/unload) : $ 100 per TEU
10. Idle time in port : 12 hours

B Mainline Mother Ship

1. Ship size : 500 TEU, 1,000 TEU, 1,400 TEU
2. Handling rate by gantry crane at Haldia: 480 TEU/day/crane x 2 cranes
3. Handling volume per ship :
   500 TEU : 600/900 TEU, 1,000 TEU : $ 600/1,800 TEU
   1,400 TEU : 600/2,400 TEU
4. Route : extension from/to Colombo or Singapore round trip basis
5. Charterage : 500 TEU : $ 5,000, 1,000 TEU : $ 9,000
   1,400 TEU : $ 12,000/day
6. Bunker Consumption : 500 TEU : F.O. 20 K/T, D.O. 1 K/T
   1,000 TEU : F.O. 40 K/T, D.O. 1.5 K/T
   1,400 TEU : F.O. 60 K/T, D.O. 1.5 K/T
7. Speed : 500 TEU : 15 knots, 1,000 TEU : 17 knots,
   1,400 TEU : 18 knots
8. Port charge : 500 TEU : $ 3,000, 1,000 TEU : $ 4,000,
   1,400 TEU : $ 5,000
9. Idle time in port : 12 hours

example, in case of mother vessels of 500 TEU, if the handling volume per vessel should increase to more than 700 TEUs, the transport cost by mother vessel would be less costly than that by feeder vessel.

This appears to indicate that there would be some possibility of the increase of the direct services in the future provided that the efficient inland transport links are realized.

However, there are other factors which strongly influence the direct services as listed before.

The container throughput demand at Haldia is estimated in the different section as follows.

Year	Alternative	Potential Throughput p.a.
1995	---	56,000 TEUs
2005	Trend case	130,000 TEUs
2005	Shifting to Haldia case	288,000 TEUs

If we assume now weekly services by 3 groups by way of slot charter, the throughput requirement is estimated as 218,400 TEUs (500 TEUs vessel), 405,600 TEUs (1,000 TEUs vessel) and 530,400 TEUs (1,400 TEUs vessel).

Here, the traffic share between eastward and westward is assumed to be similar to the present, i.e. 50 % each.

In this case, the result would be positive for 500 - 1,000 TEUs vessel size in 2005 (Shifting to Haldia case) and become negative for more than 1,000 TEUs vessel size. According to the view of the Shipping Wing of the MInistry of Surface Transport (India) and SCI, "SCI is already having plans for acquiring cellullar mainline vessels of 1,500 TEU/2,000 TEU capacity and whether to call these vessels at Haldia will depend upon the availability of infrastructure for loading cargo from Haldia. Failing this SCI will only use feeder vessels from Calcutta and Haldia or may even consider employing 450/500 TEU capacity vessels which are suitable for Calcutta draft for direct service from East Coast of India to USA Continents."

In addition, "at Haldia mainline vessels upto 750/1,000 slots can be expected to be programmed in future (from 1995 onwards)".

Considering the crucial influence of the marketing strategy of shipping lines on determining the deployment of direct calling vessels, the analysis cannot avoid uncertainty.

However, it seems fair to say the direct services via other ports en route could be expected to increase in 2005 in some routes where sufficient traffic volume is available provided that the traffic demand as estimated as well as the sufficient improvement of Haldia and its inland transport links are realized as envisaged in the later section.

Although it is envisaged that the main line vessels routing between Europe/America and Colombo/Singapore increasingly shift to the Third or even Fourth Generation in the future, the vessel sizes of the container fleet deployed in the inter regional trade (Indian Subcontinent plus Srilanka - other regions) at present are mostly 500 - 1,000 TEUs loaders (54 % of the total) (NYK Lines Data).

In conclusion, it seems that although Calcutta/Haldia Dock System will primarily remain as feeder ports fed by Colombo/Singapore/Madras with the vessel sizes increasing to 500 TEUs or more in the foreseeable future, the direct services may also be expected to increase in some routes as the traffic sufficiently increases and the efficiency of the port handling as well as the inland transport links are improved.

Chapter 8 Demand Forecast

8-1 Cargo Traffic Forecast

8-1-1 Macroscopic Forecast of Demand

1. Basic assumptions

(1) Since the roles and functions of ports vary with the socio-economic structure of their hinterlands which are largely influenced by national and regional socio-economic development policy, the future functions or roles of the Port of Calcutta and thus the basic direction of the port development should be determined in coordination with the socio-economic policy.

Now, in India, the national economic development policy is presently under the Seventh Five Year Plan 1985-90 and the work for the new economic development policy, the Eighth Five Year Plan 1990-95, is going to start soon (some work may already have started). At present the fundamental future direction of the national economic policy is not yet clear except as described in the Seventh Five Year Plan 1985-90. Thus in this Study, it is assumed that the basic direction of national and regional development will not greatly change from the recent past, and the future growth of the Indian economy is forecast considering the historical growth and the forecast growth of the world economy.

(2) Future Socio-economic framework

In this study, three alternatives, that is high, medium and low projections, are prepared. Table 8-1-1 shows the projected GDP and sectorial GDP from 1990 to 2005 and Table 8-1-2 shows the projected population from 1990 to 2005.

Table 8-1-1 Future Socio-Economic Framework (GDP Projection)

(Unit: Rs, Crores)

	India (1970-71 prices)					Annual Growth Rate				Share (%)				
	1985	1990	1995	2000	2005	90/85	95/90	00/95	05/00	'85	'90	'95	'00	'05
Medium Case														
G D P	61,693	78,738	100,492	128,256	163,691	5.0	5.0	5.0	5.0	100	100	100	100	100
Agriculture	24,924	29,527	33,564	37,579	42,076	3.4	2.6	2.3	2.3	40.4	37.5	33.4	29.3	25.7
Industry	14,066	18,503	26,329	36,938	52,748	5.6	7.3	7.0	7.4	22.8	23.5	26.2	28.8	32.2
Services	22,703	30,708	40,599	53,739	68,867	6.2	5.7	5.8	5.1	36.8	39.0	40.4	41.9	42.1
High Case														
G D P	61,693	78,738	105,369	141,007	188,699	5.0	6.0	6.0	6.0	100	100	100	100	100
Agriculture	24,924	29,527	35,193	41,315	48,496	3.4	3.6	3.3	3.3	40.4	37.5	33.4	29.3	25.7
Industry	14,066	18,503	27,607	40,610	60,761	5.6	8.3	8.0	8.4	22.8	23.5	26.2	28.8	32.2
Services	22,703	30,708	42,569	59,082	79,442	6.2	6.8	6.8	6.1	36.8	39.0	40.4	41.9	42.1
Low Case														
G D P	61,693	78,738	95,797	116,552	141,803	5.0	4.0	4.0	4.0	100	100	100	100	100
Agriculture	24,924	29,527	31,996	34,150	36,443	3.4	1.6	1.3	1.3	40.4	37.5	33.4	29.3	25.7
Industry	14,066	18,503	25,099	33,567	45,661	5.6	6.3	6.0	6.3	22.8	23.5	26.2	28.8	32.2
Services	22,703	30,708	38,702	48,835	59,699	6.2	4.7	4.8	4.1	36.8	39.0	40.4	41.9	42.1

Assumption: We assume 5 percent of GDP annual growth rate as medium case by the reasons that 1) GDP annual growth rate during 1975 to 1985 is approximately 5 percent, and 2) Seventh Five Year Plan 1985-90 assumes 5 percent as GDP annual growth rate during 1985 to 2000. Then we assume 6 percent as high case and 4 percent as low case.

Table 8-1-2 Projected Population

India (in millions)

	1986	1990	1995	2000	2005	90/86	95/90	00/95	05/00
Medium Case	758	820	897	972	1,052	2.0	1.7	1.6	1.6
High Case	758	826	922	1,030	1,151	1.7	2.2	2.2	2.2
Low Case	758	816	884	941	1,002	1.5	1.6	1.3	1.3

Assumption: we adopt the projection by "A Social and Economic Atlas of India" as medium case, the projection by CPT data as high case, and the projection by IBR as low case.

2. Cargo Traffic Method

(1) Methodology

Two methods are used to forecast the cargo volume to be handled at the Port of Calcutta. One is a macro forecast which is a method to estimate the total cargo volume as a whole including many commodities, regardless of the volume of each commodity. The other is micro forecast, which is a method to estimate the cargo volume of each commodity group individually.

Based on an analysis of the historical trend of cargo movement at the port, the cargo volume should be estimated by major commodity groups individually. The cargo forecast by commodity group is conducted based on (1) correlations with related indices such as socio-economic activities, (2) the forecast supply and demand, and by analyzing historical trends.

(2) Selection of Major Commodity Groups

The selected major commodity groups are as follows:

Import: P.O.L.(Crude), P.O.L.(products); Fertilizer; Raw Materials for Fertilizer; Coking Coal; Iron, Steel and Machinery; Cement; and Edible Oil

Export: P.O.L.(Products); Coal; Iron, Steel and Machinery, Jute and Jute Products; and Tea

(3) Forecast of Container Cargo

The volume of containerized cargo is forecast considering the future containerizable rate by commodity.

3. Macroscopic Forecast

It is generally known that the cargo handling volume of a port is closely related with the social and economic indices of the country. Talbe 8-1-3 shows the correlation between the Gross Domestic Product (GDP) of India and the cargo volume hanled at major ports in India.

Table 8-1-3 Correlation between GDP and Cargo Volume

	G D P* (million Rs)	Cargo Volume (million tonnes)	
1979/80	1,139.40	74.2	Y= -58.83 + 0.112X
80/81	1,222.26	77.4	(r= 0.978)
81/82	1,297.76	82.6	X: GDP
82/83	1,338.30	87.6	Y: Cargo Volume
84/85	1,489.55	107.8	handled at
85/86	1,560.83	120.0	Major Ports

* GDP at factor cost, in constant 1980-1981 prices

Thus, the total future cargo traffic through Calcutta/Haldia is first forecast without considering the volume of individual commodities. This is the so-called macroscopic forecast. In order to conduct the macroscopic forecast, we take the following steps.

(1) Comparison of GDP growth rate between National GDP and GDP of the hinterland for Calcutta/Haldia. (Table 8-1-4)

(2) Estimation of the elasticity of cargo volume to GDP (hinterland).

(3) Estimation of the average annual growth rate of cargo through Calcutta/Haldia.

(4) Macroscopic forecast of the cargo volume of Calcutta/Haldia.

Table 8-1-4 GDP growth rate: national and the hinterland of Calcutta/Haldia

(Unit, Rs Crores, %)

Year	GDP (National base)	GDP* (Hinterland)
1975/76	42,890	17,560
1980/81	50,623	21,220
1984/85	61,693	25,100
Annual Growth Rate		
1976/81	3.3	3.9
1981/85	5.1	4.3
1976/85	4.1	4.0

Source: India, Economic Information Yearbook 1987-88

* Hinterland of GDP means West Bengal, Bihar, Madhya Pradesh, Uttar Pradesh, Punjab, Assam, Orrisa and Delhi from CPT sources.

From the above Table, we can estimate that the annual growth rate of GDP (hinterland)is about 97 percent of the growth rate of GDP (National base) during 1976-85.

Table 8-1-5 shows the cargo volume movement at Calcutta/Haldia since 1977/78. From this table we can see that the annual growth rate of the cargo volume at Calcutta/Haldia is about 5.3 percent during 1977/78 to 1987/88. So the elasticity of cargo volume to GDP (hinterland: 4.0 percent) is approximately 1.30. Based on the estimated future economic growth (GDP: national base in Table 8-1-1), the annual growth rate of the cargo volume at Calcutta/Haldia is estimated using the above elasticity.

Table 8-1-5 Cargo Volume Movement

(Unit: '000 tonnes)

	Total	Cargo Volume	
		Calcutta	Haldia
1977-78	7,806	4,350	3,456
78-79	8,238	4,391	3,847
79-80	8,796	3,843	4,953
80-81	9,512	4,066	5,446
81-82	9,926	4,448	5,478
82-83	10,691	4,575	6,116
83-84	10,468	4,088	6,380
84-85	10,524	3,988	6,536
85-86	11,827	4,163	7,664
86-87	12,072	4,047	8,025
87-88	13,071	4,393	8,678
Annual growth rate (%)	5.3	(-) 0.1	9.6

Table 8-1-6 Estimated Annual Growth Rate of Cargo Volume through Calcutta/Haldia

(Unit: %)

	1990-1995	1995-2000	2000-2005
Medium Case	6.3	6.3	6.3
High Case	7.5	7.5	7.5
Low Case	5.0	5.0	5.0

GDP (national base) annual growth rate rate x 0.97 x 1.30
0.97: for GDP (hinterland)
1.30: elasticity of cargo volume to GDP (hinterland)

The future cargo volume by the macroscopic forecast is estimated based on the estimated growth rate in Table 8-1-6 as follows: